Cordova System Water Master Plan

Golden State Water Company

December 2019

Executive Summary

Purpose

The purpose of this Master Plan is to assess Golden State Water Company's (GSWC) Cordova System's ability to meet current and future water needs, and to identify upgrades needed if deficiencies exist. This assessment is developed by using hydraulic analysis criteria, future demands and available supply, water quality standards, and condition of facilities.

These updates provide GSWC with a basis to determine the impacts of new development on the existing system and to identify system deficiencies and improvements needed to correct them. These system improvement needs are used as the basis for developing the Capital Improvement Program (CIP) for the system. TABLE 9-1 summarizes the CIP projects identified in this master plan.

GSWC's goal is to meet the minimum requirements identified in the technical memorandum titled *Golden State Water Company Master Planning Criteria and Standards* (see Appendices).

Master Plan Process

This master plan document is organized as follows:

- Update existing system information
- Establish existing demands and forecast future demands
- Update system's hydraulic model
- Evaluate supply and storage capacities
- Perform hydraulic analyses and evaluation
- Identify water quality issues
- Assess condition of facilities in the system
- Develop CIP

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Acronyms and Abbreviations

1,1-DCE	1,1-dichloroethylene
2015 UWMP	2015 Urban Water Management Plan
2016 WMP	Cordova 2016 Water Master Plan
AACE International	Association for the Advancement of Cost Engineering International
ADD	average day demand
AFY	acre-feet per year
amsl	above mean sea level
AOB	ammonia-oxidizing bacteria
Cal-Am	California American Water Company
CIP	capital improvement program
CPUC	California Public Utilities Commission
DDW	State Water Resources Control Board, Division of Drinking Water
DPB Rule	Disinfectants and Disinfection Byproducts Rule
DWR	California Department of Water Resources
EPA	U.S. Environmental Protection Agency
FCV	flow-control valve
FSC	Folsom South Canal
fps	foot or feet per second
GAC	granular activated carbon
gpm	gallons per minute
GSWC	Golden State Water Company
GWO	General Work Order
HPC	heterotrophic plate count
IDSE	Initial Distribution System Evaluation
MCL	maximum contaminant level
MDD	maximum day demand
MG	million gallons

MHD	minimum hour demand
NAICS	North American Industry Classification System
NOB	nitrite-oxidizing bacteria
O&M	operations and maintenance
PCE	tetrachloroethylene
PHD	peak hour demand
PRV	pressure-regulating valve
psi	pounds per square inch
PSV	pressure-sustaining valve
SCADA	supervisory control and data acquisition
SCWA	Sacramento County Water Agency
SDWA	Safe Drinking Water Act
SWTP	Surface Water Treatment Plant
TDS	total dissolved solids
TTHM	total trihalomethanes
UWMP	Urban Water Management Plan
VOC	volatile organic compound
WMP	Water Master Plan

SECTION 1

Introduction

1.1 Overview of Golden State Water Company

GSWC is a subsidiary of American States Water Company, an investor-owned utility dedicated to increasing value through the expert management of utility assets and services. As a public utility, GSWC is committed to the purchase, production, distribution, and sale of water to over 260,000 customer connections.

GSWC is organized into three regions throughout the state of California. Region I is located in northern and central coast of California. Region II serves communities in Los Angeles County. Region III serves communities in Los Angeles, San Bernardino, Imperial, and Orange counties.

FIGURE 1-1, provided at the end of this section, shows the locations of all GSWC water systems.

1.2 Master Plan Update

The purpose of this master plan is to assess the Cordova System's ability to meet current and future water needs and recommend system upgrades needed to meet current customer needs. This assessment is developed by using hydraulic design criteria, water quality standards, system demands and available supply, and facility condition assessments.

Specifically, this master plan supports GSWC's effort to update existing master plans and hydraulic models for water systems throughout the company. These updates provide GSWC with a baseline for determining the impacts of new development on existing systems as well as identifying short, mid, and long term system needs. These system needs are used as the basis for developing the capital improvement program (CIP) for the system. The primary drivers of this master plan update are the following:

- Assess the distribution system's hydraulic performance
- Identify infrastructure that is in poor condition and needs to be replaced
- Identify supply and storage needs
- Identify water quality and treatment needs
- Provide documentation for the proposed CIP projects in support of the General Rate Case for the California Public Utilities Commission (CPUC)
- Reduce operations and maintenance (O&M) efforts and costs required to maintain service under current conditions
- Minimize service failures

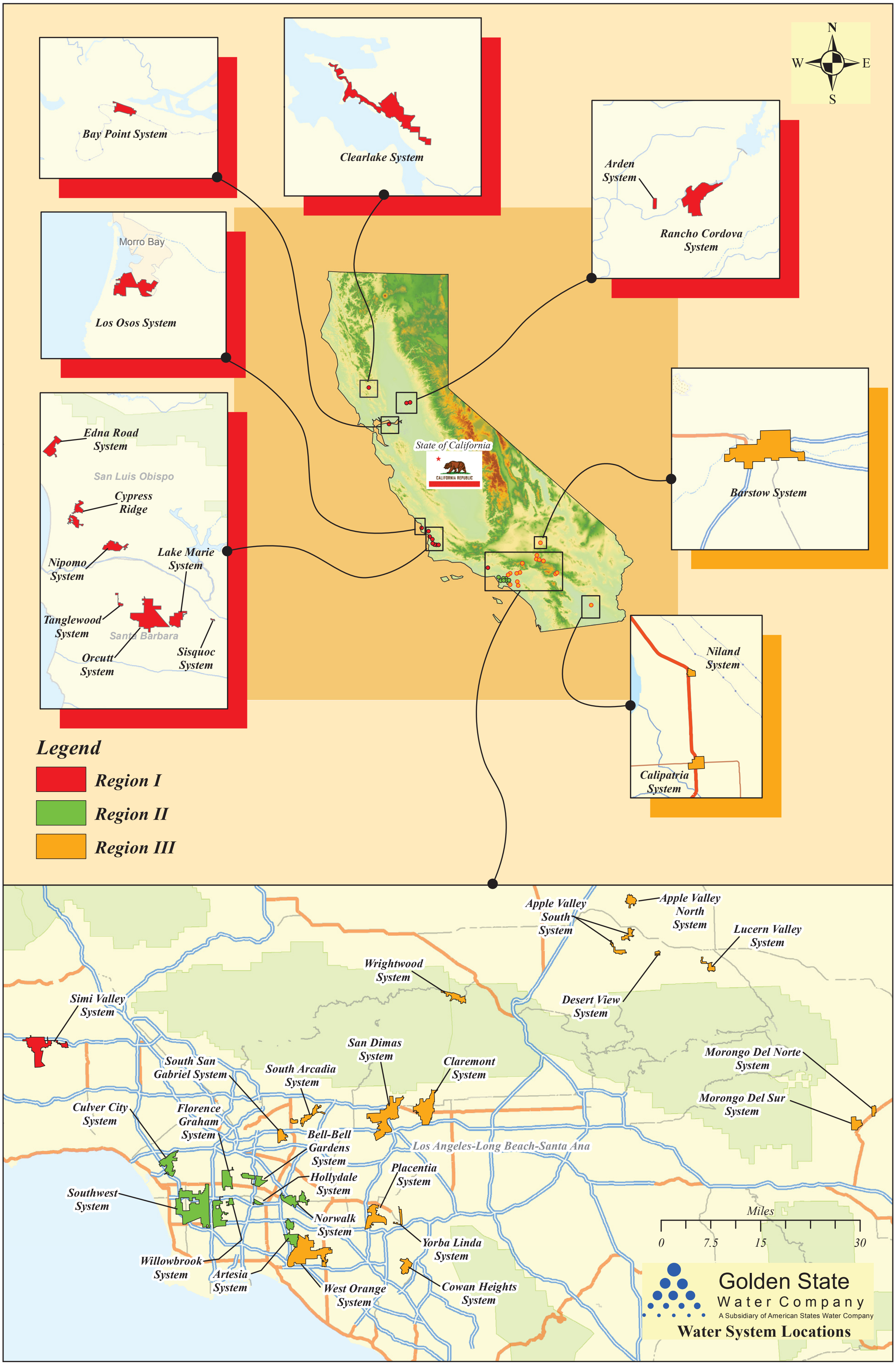
1.3 Document Organization

This master plan document is organized to provide information in a sequential manner that considers historical progression (past to present to future) and logical evaluation of the system from existing facilities and requirements through future needs. Each section's title and a brief summary are as follows:

1. **Introduction:** Provides background information on the company and its systems.
2. **Existing Water System Facilities:** Provides an overview of the system and its facilities. System facilities identified include the system service area boundary, pressure zones, distribution areas, supply sources, storage facilities, pump stations, pressure regulating and water control stations, and transmission and distribution pipelines.
3. **Existing and Future Demands:** Provides definition of demand types and periods, as well as existing and future demands. Explains the demand development approach and determination of peaking factors. Provides the current demands and projected demands developed for a future 2040 condition. Future demands are based on population growth rate and water use projections.
4. **Hydraulic Model Development and Calibration:** Provides an overview of the modeling process, including hydraulic model construction and calibration.
5. **Supply and Storage Capacity Evaluation:** Documents the evaluation of the system's water supply and storage capacity using the objectives identified in GSWC's *Master Planning Criteria and Standards.* The evaluation results establish supply and storage needs for each distribution area and the entire distribution system. Existing and future supply and storage deficiencies are also identified. Recommended improvements to mitigate deficiencies are also provided.
6. **Hydraulic Analysis and Evaluation:** Outlines the approach for the hydraulic analysis. Details how the updated hydraulic model was used to determine hydraulic deficiencies under simulated demand scenarios and was compared with the analysis and planning criteria for short, mid, and long term planning periods. Provides recommendations to address deficiencies that were identified. Scenarios simulated by the hydraulic model include average day, maximum day, and peak hour conditions.
7. **Water Quality Analysis:** Provides GSWC's evaluation of water quality based on current and pending federal and state standards and rules.
8. **System Condition Assessment:** Provides GSWC's documentation of system condition assessment efforts including past efforts, recent field inspections, and recommendations for future improvements.
9. **Capital Improvement Program:** Describes the CIP plan resulting from all preceding tasks broken down into short, mid, and long term planning periods. This includes prioritization and justification for the projects included in the CIP.
10. **References:** Lists the primary sources of information referred to throughout the master plan.

Appendices provide supporting information on various specifications and details referred to throughout the master plan.

Figures



GSWC Engineering Planning October 2017

SECTION 2

Existing Water System Facilities

This section documents existing water system facilities for the Cordova System. Detailed information about the major facilities, such as water supply facilities, storage facilities, pipelines, pumping facilities, and regulating valves serves as the basis for subsequent system analysis throughout the master plan. This section begins with an overview of the system, and then presents detailed information about these facilities.

2.1 Overview

The Cordova System is located in Sacramento County, covers approximately 12.1 square miles, and serves a portion of the City of Rancho Cordova and the unincorporated Sacramento County community of Gold River.

The Cordova System obtains its water supply through: nine active groundwater wells in the South American Sub basin (as defined in DWR Bulletin 118 (2003)), which is managed by the Sacramento Central Groundwater Authority; surface water from the American River; and "replacement" water supplied by Aerojet per the 2004 Master Settlement Agreement and Release (Settlement Agreement) between Aerojet and GSWC. (Replacement water is supplied to offset groundwater lost to contamination in the basin.) In January 2017, GSWC began receiving 5,000 ac-ft/yr (~4.5 MGD) replacement water via Carmichael Water District, pursuant to the terms of the Settlement Agreement with Aerojet.

Surface water from the American River is withdrawn via the Folsom South Canal, and is treated at the Coloma Water Treatment Plant and the Pyrites Water Treatment Plant. No recycled water supply is available for this system.

The Cordova System has approximately 187 miles of pipelines that range in diameter from 2 to 30 inches.

2.2 Facility Descriptions

The major system facilities are shown in FIGURE 2-1 at the end of this Section. These facilities are discussed in detail in the following subsections:

- Pressure zones
- Supply sources
- Storage facilities
- Pumping stations
- Pressure regulating stations and flow control stations
- Transmission and distribution pipelines

2.2.1 Pressure and Distribution Zones

The Cordova System is comprised of two pressure zones. TABLE 2-1 provides details of these pressure zones and lists the PRVs and/or booster stations that connect the East and

West zones. FIGURE 2-2 presents the system's hydraulic profile (schematic of the water system).

TABLE 2-1 Pressure Zone Details

Pressure Zone	HGL (ft msl)	Elevations Served (ft msl)	Supply and Storage Facilities*		
			Storage Tanks	Wells and Purchased Water	PRV/Booster Stations
Cordova West Zone	210	74–120	Stone Creek Reservoir, Oselot Tank	Agnes Well #8, Capital Well #23, Dolecetto Well #6, Mather Well #18 and Paseo Well #24 Carmichael Water District Interconnection via American River Pipeline	Gold Express, Coloma, Folsom, Trade Center Drive, and Citrus PRVs Oselot Booster Station, Oselot Tank PRV (altitude valve)
Cordova East Zone	240	104–147	Coloma Treatment Plant reservoirs	Coloma Well #20, Park Well #17, South Bridge Street Wells #22A and #22B Coloma Treatment Plant and Pyrites Treatment Plant[a]	Coloma Booster Station

* Does not include hydropneumatic tanks or emergency interconnections.
[a] The capacity of the Coloma Treatment Plant is 7,680 gpm, and the capacity of the Pyrites Treatment Plant is 3,500 gpm.

2.2.2 Supply Sources

GSWC currently obtains its water supply for the Cordova System from three primary sources: local groundwater from wells owned and operated by GSWC, surface water, and "replacement" water from Aerojet. Emergency interconnections are available with the City of Folsom, County of Sacramento and California American Water (Cal-Am), but these are used only under emergency conditions and/or when regular supplies are not available.

Groundwater

The system has eight active wells; their locations are identified in FIGURE 2-1. A disinfectant – sodium hypochlorite – is added to the water before it is discharged to the system. Coloma Road Well #20 also has a manganese filter, and Capital Well #23, Mather Well #18 and Dolecetto Well #6 have wellhead treatment for perchlorate.

Groundwater contamination in the Cordova System is a serious concern. A number of wells have been abandoned/destroyed due to contamination, and a long-term groundwater monitoring program is in place to detect migration of the contamination plume that may adversely affect active GSWC wells. Current monitoring indicates that Aerojet groundwater extraction and treatment (GET) facilities are capturing the plume, but there is a still a degree of risk – especially in the event that GSWC would need to increase groundwater pumping activity.

Active Wells

Eight groundwater wells were identified as active for this master plan. TABLE 2-2 presents the relevant data for these wells. The elevation shown for each well is the elevation of the wellhead facilities. The pumping water level is the depth measured from the wellhead to the surface of the groundwater while the well pump is running. Pumping water levels were based on recent levels monitored and recorded by GSWC. The groundwater elevation was calculated by subtracting the pumping water level from the wellhead elevation. Well capacities are based on facility design capacities, which may vary slightly with recent pump test data. Total dynamic head (TDH) represents the amount of energy required by the pump to produce water at the given flow rate. The discharge location describes where the well pump discharges.

TABLE 2-2 Active Wells

Well	Discharge Location	Wellhead Elevation (ft msl)	Pumping Water Level (ft)	Pumping Groundwater Elevation (ft msl)	TDH[a] (ft)	Capacity[b] (gpm)
Agnes #8	West Zone	80	114	-34	260	500
Coloma #20	East Zone	118	234	-116	230	2,500
Dolecetto #6	West Zone	87	117	-30	336	750
Mather #18	West Zone	96	153	-57	333	1,800
Park #17	East Zone	113	111	2	250	1,400
Paseo #24	West Zone	81	154	-73	326	1,050
S. Bridge Street 22A	East Zone	107	117	-10	250	3,200
S. Bridge Street 22B	East Zone	107	122	-15	333	2,800
Total groundwater production capacity						**14,000**

msl: above mean sea level

[a] TDH is based on pump design point data.
[b] Capacity is based on facility design capacity, under normal operating conditions, and may not reflect actual capacity at a given point in time.

Non-operational Wells

The system has one non-operational well. A summary is provided in TABLE 2-3.

TABLE 2-3 Non-Operational Wells

Well	Discharge Location	Elevation (ft msl)	Previous Capacity (gpm)	Reason
Capital #23	West Zone	101	2,200	Groundwater contamination; work is underway to determine/update well capacity (could be ≥750 gpm)

Purchased Water

Historically, groundwater was the Cordova System's primary supply and was supplemented by treated surface water only when groundwater production capacity was insufficient to meet demands. Beginning in 1997, however, groundwater contamination became a major concern in the Cordova System and has resulted in several (16) wells becoming non-operational. The migration of contamination plumes that may adversely affect currently active wells is closely monitored. This issue is causing increasing reliance on surface water supplies, requiring that the Cordova System exercises its rights to 5,000 AFY of American River water. All surface water is treated at the Coloma (7,680 gpm capacity) and Pyrites (3,500 gpm capacity) treatment plants. Long-term replacement water will be provided by Aerojet, the source of contamination, to make up for lost GSWC groundwater.

The Cordova System has one imported water supply connection[a]; 4.5 MGD of remediated groundwater that is discharged to the American River by Aerojet and then extracted and treated by Carmichael Water District (CWD) and provided to the Cordova System via the American River Pipeline, pursuant to the terms of agreements with Aerojet and CWD.

TABLE 2-4 Imported Water Supply Connections

Imported Water Supply Connection	Hydraulic Grade Line (ft)	Capacity (gpm)	Pressure Setting at Connection* (psi)	Ground Surface Elevation (ft msl)	Imported Water Supply Pipeline
Carmichael Water District (CWD) Interconnection	250	3,125	69	100	American River Pipeline (ARP)

* The fixed-head elevation at the service connection is calculated as the sum of the elevation of the centerline of the control valve and the pressure head from the pressure setting.

[a] Other than the CWD Interconnection, all imported water for the Cordova System is "raw" surface water from the American River through GSWC's intake at the Folsom South Canal. GSWC possesses a pre-1914 appropriative right to divert up to 10,000 AFY from the American River via the Folsom South Canal at a maximum withdrawal rate of 20 cubic feet per second (cfs), or 13 mgd. In 1994 GSWC entered into an "Agreement for Reallocation of Water under Co-Tenancy Agreement" with the City of Folsom to lease 5,000 AFY of water rights to the City of Folsom in perpetuity; the company retained 5,000 AFY of its right, which is diverted from the Folsom South Canal for use within the Cordova System. However, if the City of Folsom were to exercise its right to divert its leased 5,000 AFY from the Folsom South Canal intake location, GSWC's maximum withdrawal rate would be limited to 10 cfs, or 4,500 gpm (6.5 MGD).

Emergency Interconnections

Water distribution systems are often connected to neighboring water systems to allow the sharing of supplies during short-term emergencies or during planned shutdowns of a primary supply source. The system has one interconnection with the City of Folsom, one with the County of Sacramento, and two with California American Water Company; all of these interconnections are "normally closed" and must be manually opened to provide flow. These emergency interconnections are presented in TABLE 2-5.

TABLE 2-5 Emergency Interconnections

Interconnection Name/Location	Capacity (gpm)	Notes
Mills Tower Drive, west of Glenview Way	880	6-in interconnection with Cal-Am
International Drive and S. White Rock Rd.	3,550	12-in interconnection with Cal-Am
Femoyer St., south of International Drive	3,550	12-in interconnection with Sacramento County Water Agency (SCWA)
Hazel Ave., north of Folsom Blvd.	3,550	12-in interconnection with City of Folsom

* Capacity of an emergency interconnection is not considered a reliable supply; rather, it is considered an "interruptible" supply, as it is based on whether or not the neighboring water agency has available water.

2.2.3 Storage Facilities

Water distribution systems rely on stored water to help equalize fluctuations between supply and demand, to supply sufficient water for firefighting, and to meet demands during an emergency or an unplanned outage of a major supply source. This section describes the existing storage facilities in the system.

Storage Tanks

The Cordova System has six storage tanks, three of which are considered clearwells. Five of the tanks are ground-level (four at Coloma and one at Oselot) with booster stations, and one is elevated (Stone Creek). A summary of the Cordova System reservoirs is provided in TABLE 2-6.

TABLE 2-6 Storage Tanks

Tank	Type and Zone	Bottom of Tank (ft msl)	High Water Elevation (ft msl)	High Water Level (ft)	Diameter (ft)	Volume (MG)
Coloma 1	Ground level pumped to Cordova East Zone	116	148	31.5	74	1.00
Coloma 2	Ground level with gravity flow to Coloma 1	116	148	31.5	74	1.00
Coloma 3	Ground level with gravity flow to Coloma 2	116	148	31.5	104	2.00
Coloma 4	Ground level pumped to Cordova East Zone	116	148	31.5	165	5.00
Stone Creek Reservoir	Gravity to Cordova West Zone	113.5	229	113.5	50	0.50
Oselot Tank	Ground level pumped to Cordova West Zone	96.5	128	31.5	165	5.00
Total systemwide storage capacity						**14.50***

* The Coloma Treatment Plant's total storage capacity is 9.0 MG, but 1.2 MG is dedicated to CT requirements within the three clearwells (Coloma Reservoirs 1, 2 & 3), and the balance (7.8 MG) is available for system storage. Therefore, a total of 13.3 MG is available for the distribution system when the Coloma Treatment Plants are in operation from Spring through early Fall. The Plants are offline during the Winter months, and 14.5 MG of storage is available.

2.2.4 Pumping Stations

Pumping stations are required to convey water from ground-level tanks into the distribution system or from lower-pressure zones into higher-pressure zones (usually called booster pumping stations). Pumping stations may consist of one or more individual pumps. Multiple pumps at each station, or multiple pumping stations that serve the same pressure zone, help to increase water system reliability by ensuring that water can still be delivered into that zone if one pump is out of service. Critical pumping stations may be equipped with emergency power supplies in case of failure of the primary power source.

The Cordova System includes 27 booster pumps. The Folsom Canal Turnout, which delivers raw water from the Folsom South Canal to the Coloma/Pyrites Treatment Plant, has five boosters, including one variable-frequency drive (VFD) pump. The Coloma Treatment Plant has five settled water boosters, the Pyrites Treatment Plant has three filtered water boosters, and the combined Treatment Plant has nine finished water booster pumps, two of which are gas-powered. The two gas engine boosters and Finished Water Booster I at Coloma Treatment Plant are variable speed. There are five booster pumps located at the Oselot Plant with a diesel driven generator that is sized to supply backup electrical power for all five boosters running at the same time.

TABLE 2-7 presents booster pump data relevant to the water system analysis. The Folsom Canal Turnout boosters and the Coloma/Pyrites Treatment Plant settled/filtered water boosters are not included, as the hydraulic model representation of the distribution system begins with treated water at the Coloma/Pyrites Treatment Plants.

TABLE 2-7 Booster Pumps

Facility	Pressure Zone		Backup Power Available	Elevation (ft msl)	TDH[a] (ft)	Capacity[b] (gpm)
	Suction	Discharge				
Coloma Booster A	Coloma Treatment Plant	East Zone	Natural Gas	116	140	4,000
Coloma Booster B	Coloma Treatment Plant	East Zone	Natural Gas	116	140	4,000
Coloma Booster C	Coloma Treatment Plant	East Zone	-	116	120	2,000
Coloma Booster D	Coloma Treatment Plant	East Zone	-	116	120	2,000
Coloma Booster E	Coloma Treatment Plant	East Zone	-	116	120	2,000
Coloma Booster F	Coloma Treatment Plant	East Zone	-	116	120	2,000
Coloma Booster G	Coloma Treatment Plant	East Zone	-	116	120	2,000
Coloma Booster H	Coloma Treatment Plant	East Zone	-	116	120	2,000
Coloma Booster I	Coloma Treatment Plant	East Zone	-	116	140	4,000
Oselot Booster A	Oselot Tank	West Zone	Diesel Generator	97	130	1,250
Oselot Booster B	Oselot Tank	West Zone	Diesel Generator	97	130	1,250
Oselot Booster C	Oselot Tank	West Zone	Diesel Generator	97	130	1,250
Oselot Booster D	Oselot Tank	West Zone	Diesel Generator	97	130	2,000
Oselot Booster E	Oselot Tank	West Zone	Diesel Generator	97	130	2,000

msl: above mean sea level

[a] TDH is based on pump design point data.
[b] Capacity is based on facility design capacity.

2.2.5 Pressure Regulating and Flow Control Stations

Pressure regulating and flow control stations allow distribution systems to transfer water from higher pressure zones to lower pressure zones without exceeding the allowable pressures in the lower zones or completely depressurizing the higher zone. The water is transferred through a valve that reduces the pressure or controls the flow rate to a specified setting. Regulating valves can operate based on one or more controlling parameters. The operational controls important to this analysis include pressure reducing, pressure sustaining, pressure relief, and flow rate:

- **Pressure reducing valve (PRV):** modulates to maintain a preset minimum downstream pressure setting; if the downstream pressure drops, then the valve will open until the downstream pressure matches the pressure setting.

- **Pressure sustaining valve (PSV):** modulates to maintain a preset minimum upstream pressure setting; if the upstream pressure drops, then the valve will close until the upstream pressure matches the pressure setting.
- **Pressure relief valve:** opens when the upstream pressure exceeds a preset maximum pressure setting.
- **Flow control valve (FCV):** modulates to maintain a preset flow rate through the valve regardless of pressure.

Under normal Summer (high demand) operating conditions, water flows from the Cordova East Zone to the Cordova West Zone by way of five PRVs; there is a difference of approximately 5-10 psi between zones. Under normal Winter (low demand) operating conditions, the Coloma and Pyrites Treatment Plants are offline and water flows from the Cordova West Zone to Coloma Reservoir 4 via the reservoir's altitude valve.

The Oselot PRV/altitude valve regulates the flow from the Cordova West Zone into the Oselot Reservoir and also provides overflow protection for the reservoir. The PRV is closed when the Oselot boosters are pumping water from the reservoir back into the Cordova West Zone.

The elevated Stone Creek Reservoir is equipped with a mechanical altitude valve that ensures the tank does not overfill.

TABLE 2-8 lists the relevant data for these valves.

TABLE 2-8 Pressure Regulating and Flow Control Valves

Name/Location	Pressure Zone: Upstream	Pressure Zone: Downstream	Type	Dia. (in)	Upstream Setting (psi)	Downstream Setting (psi)	Maximum Capacity[c] (gpm)
Gold Express (Gold Express Drive and Gold Spring Ct.)	Cordova East	Cordova West	PRV	8	56	45	2,450
Coloma (Coloma Rd.and Citrus Drive)	Cordova East	Cordova West	PRV	12	52	44	6,250
Folsom (Folsom Blvd. and Sunrise Blvd.)	Cordova East	Cordova West	PRV	12	52	44	3,550
Trade Center (Trade Center Drive, west of Citrus Rd.)	Cordova East	Cordova West	PRV	8	48	44	3,100
North-South (Citrus Rd., west of Treatment Plant)	Cordova East	Cordova West	PRV	16	52	45	11,000
Oselot Tank	Cordova West	Oselot Tank	Altitude/PRV	12	65-51[a]	N/A	6,250
Stone Creek Reservoir	Cordova West	Stone Creek Reservoir	Altitude	16	48[b]	N/A	6,250
Res 4 - Winter	Cordova West	Reservoir 4	Altitude/PRV	16	42	N/A	6,250
Res 4 - Summer	Cordova East	Reservoir 4	Altitude/PRV	16	52	N/A	6,250

[a] There is a pressure sustaining function on the altitude valve; when the Oselot boosters are not in operation, the valve will open so the tank can fill between the levels of 15 and 27 feet.
[b] The altitude valve will close when the level in the elevated reservoir reaches 112 feet.
[c] Maximum capacity determined by lesser of 1) PRV capacity or 2) upstream/downstream pipeline size (flow at 10 ft/s).

2.2.6 Transmission and Distribution Pipelines

The system includes approximately 187 miles of pipelines ranging from 2 to 30 inches in diameter. TABLE 2-9 lists the estimated footage of pipelines by diameter and material.

TABLE 2-9 Pipes by Size and Material

Diameter (in)	Length of Pipe by Material (ft)							Total Length (ft)
	AC	CI	DI	HDPE	LP HDPE	PVC	STL	
2	-	-	96	-	-	7,304	1,861	9,261
4	32,232	-	2,867	-	-	9,997	-	45,096
6	222,401	-	6,209	-	-	17,939	-	246,549
8	163,021	15	141,795	-	-	31,553	206	336,590
10	49,286	520	1,017	-	-	2,769	-	53,592
12	76,609	-	59,579	-	-	46,210	529	182,926
14	4,905	-	2,093	-	-	1,530	-	8,528
16	14,242	90	41,029	-	-	4,438	-	59,799
18	-	-	3,532	-	-	-	-	3,532
20	-	-	776	-	-	-	-	776
24	-	-	30,884	-	4,085	-	-	34,969
30	-	-	3,474	946	-	-	-	4,420
Totals (ft)	**562,696**	**625**	**293,351**	**946**	**4,085**	**121,741**	**2,595**	**986,040**
Totals (mi)	**106.6**	**0.1**	**55.6**	**0.2**	**0.8**	**23.1**	**0.5**	**186.7**
Percent (%)	**57.1**	**0.1**	**29.8**	**0.1**	**0.4**	**12.3**	**0.3**	**100**

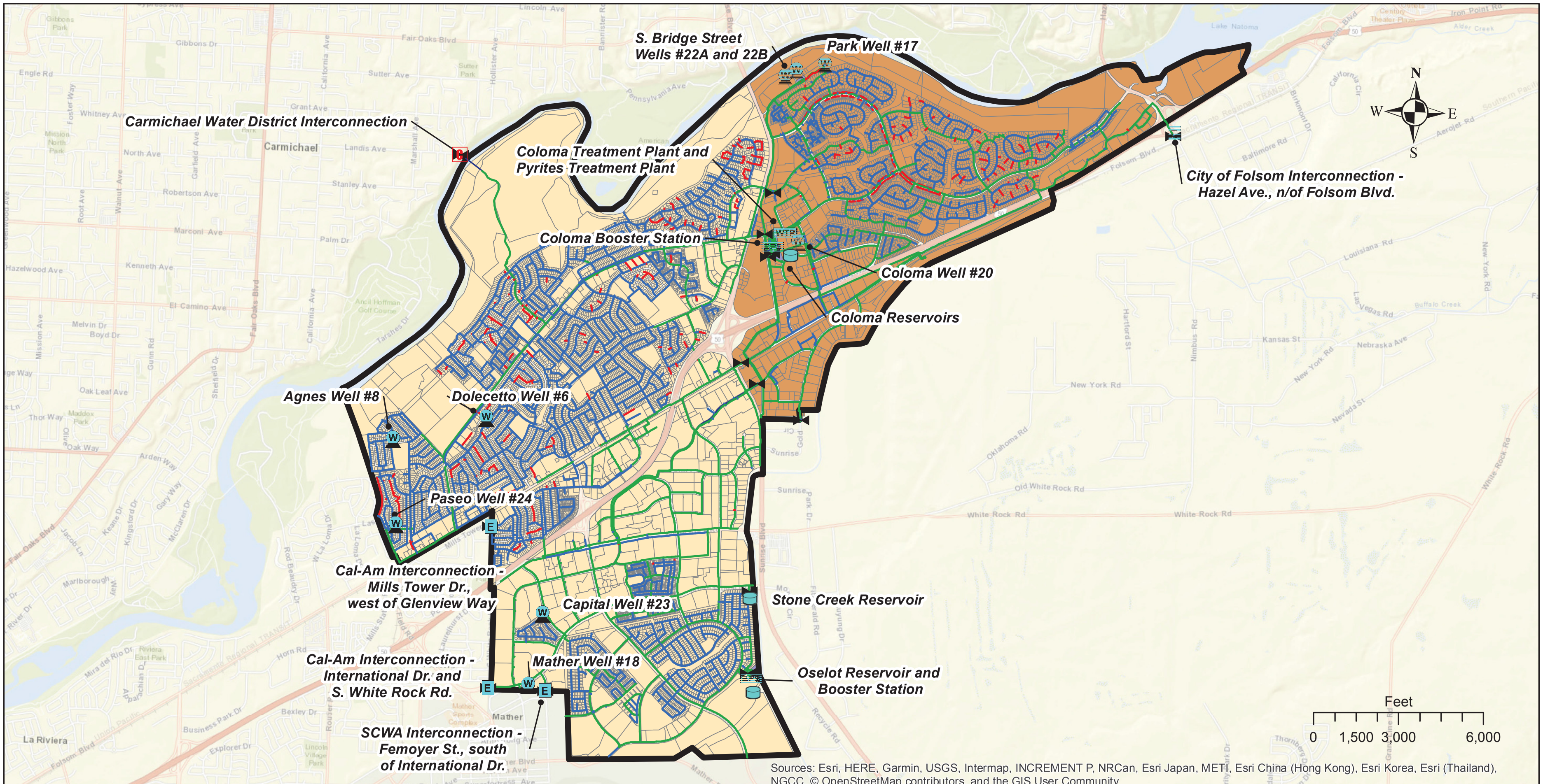
AC: asbestos cement or transite
CI: cast iron
DI: ductile iron
HDPE: high-density polyethylene
LP HDPE: low pressure HDPE
PVC: polyvinyl chloride
STL: steel

TABLE 2-10 lists the estimated footage of pipelines by diameter and year constructed.

TABLE 2-10 Pipes by Size and Year Built

Diameter (in)	Length of Pipe by Year Built (ft)				Total Length (ft)
	Pre 1960	1960-1979	1980-1999	2000-2019	
2	393	1,348	7,425	96	9,261
4	-	29,756	13,880	1,460	45,096
6	-	184,268	60,203	2,077	246,549
8	137	114,950	99,189	122,314	336,590
10	481	15,413	36,868	830	53,592
12	426	10,669	121,315	50,516	182,926
14	-	3,419	4,987	122	8,528
16	-	4,927	22,455	32,417	59,799
18	-	-	-	3,532	3,532
20	-	-	49	727	776
24	-	1,936	13,205	19,828	34,969
30	-	-	-	4,420	4,420
Totals (ft)	**1,436**	**366,686**	**379,577**	**238,341**	**986,040**
Totals (mi)	**0.3**	**69.4**	**71.9**	**45.1**	**186.7**
Percent (%)	**0.1**	**37.2**	**38.5**	**24.2**	**100**

Figures



Existing Facilities

- BPS Booster Pump Station
- Reservoir
- WTP Water Treatment Plant
- Well
- Regulating Valve
- E Emergency Interconnection
- C Supply Connection

Pipelines

- Less than 6"
- 6" or 8"
- 10" or Greater

Pressure Zones

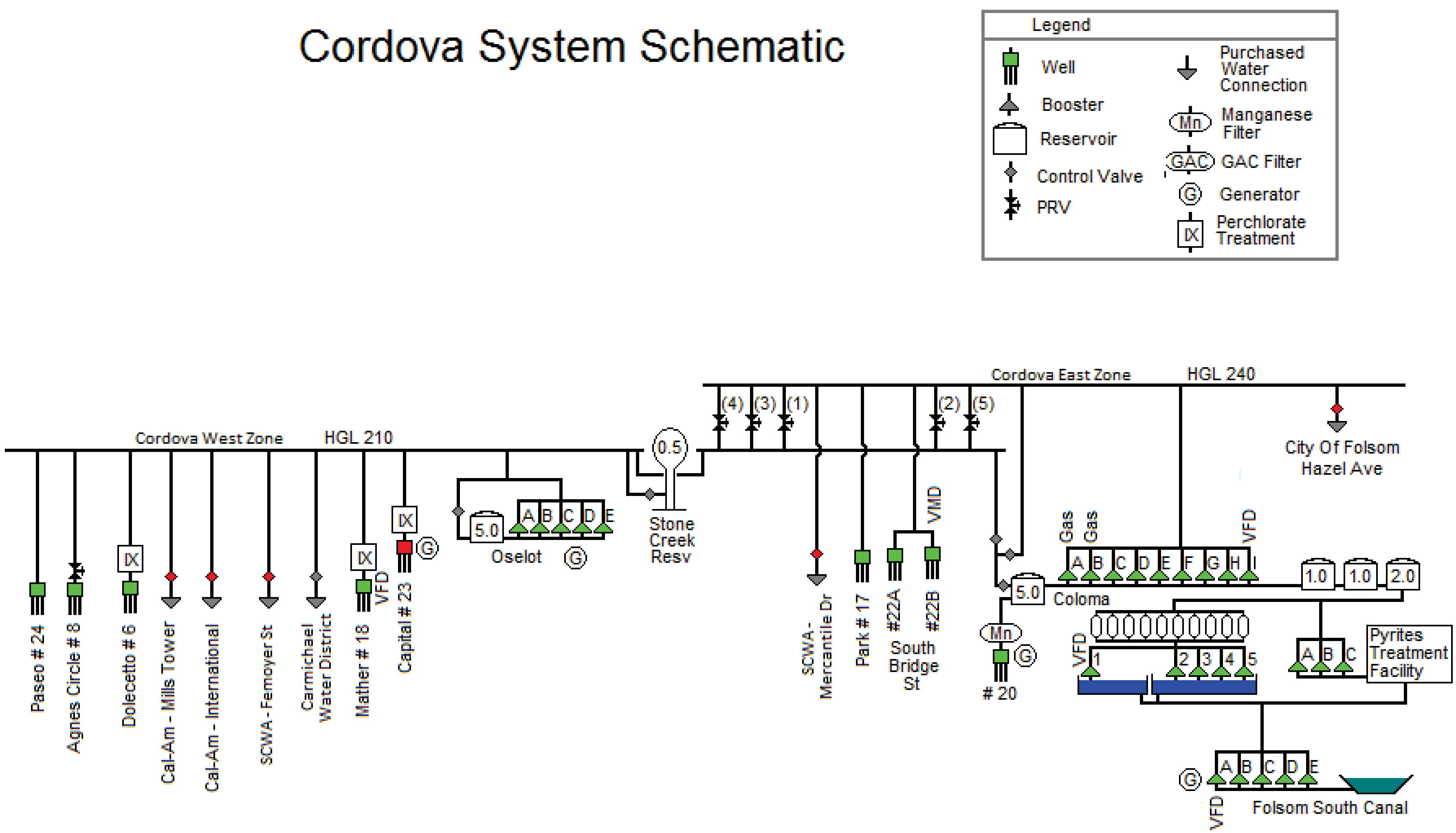
- West Zone
- East Zone
- Cordova System Boundary

FIGURE 2-1
MAJOR SYSTEM FACILITIES

GSWC REGION I MASTER PLAN
CORDOVA SYSTEM

Golden State Water Company
A Subsidiary of American States Water Company

Last Update: 3/7/2019



PRVs

(1) - Gold Express & Gold Springs
(2) - Coloma & Citrus
(3) - Folsom & Sunrise
(4) - Trade Center W/ Citrus
(5) - Citrus S/ Coloma

FIGURE 2-2
SYSTEM SCHEMATIC
GSWC REGION I MASTER PLAN
CORDOVA SYSTEM

Golden State Water Company
A Subsidiary of American States Water Company

SECTION 3

Existing and Future Water Demands

This section documents existing and future water demands for the system and contains the following information:

- Demand definitions and scenarios
- Existing demands
- Peaking factors
- Future demand projections

3.1 Demand Definitions and Periods

Demand is classified in two basic ways:

- Demand: The total quantity of water required for a given period of time to meet the water system's various uses. These uses may include residential, commercial, industrial, and other revenue and non-revenue demands.
- Non-revenue water: The difference between the total amount of water produced from water supply sources and the total amount of water delivered to customers. This includes water used for firefighting, flushing, water lost due to system leaks and illegal connections. For systems without meters for all customers, this demand classification may not be quantifiable.

The water industry commonly uses several demand periods for developing water distribution system master plans. These demand periods are designated as average day demand (ADD), maximum day demand (MDD), peak hour demand (PHD), and maximum day demand plus fire flow (MDD+FF), and were applied as necessary to evaluate the system. The American Water Works Association (AWWA, 2005) defines these common steady-state demand periods as follows:

- ADD: Total amount of water delivered to the system in 1 year divided by 365 days.
- MDD: Maximum amount of water delivered to the system in any single day of the year.
- PHD: Amount of water required to meet peak demands during MDD. GSWC applies PHD for four hours when analyzing system supply and storage.
- MDD+FF: Amount of water required to fight a fire in addition to MDD.

3.2 Existing Demands

The existing demands represent a baseline for evaluating the existing system and to project future demands. The data used to develop the existing demands was based on historical water production data provided by GSWC.

3.2.1 Historical Water Use

For this master plan, it was assumed that the historical water production equaled the historical water demand (including non-revenue water). TABLE 3-1 summarizes historical annual water production from 2009 through 2018. The average water demand per connection for this period was 1.00 acre-feet per year per connection (AFY/conn.).

TABLE 3-1 Historical Annual Water Production

Year	Active Service Connections	Total Demand (AFY)*	Average Demand per Connection (AFY/conn.)
2009	14,427	17,677	1.23
2010	14,456	16,479	1.14
2011	14,492	15,120	1.04
2012	14,537	15,953	1.10
2013	14,468	16,394	1.13
2014	14,570	13,954	0.96
2015	14,676	11,594	0.79
2016	14,998	12,790	0.85
2017	15,143	13,293	0.88
2018	15,277	13,456	0.88
10-year average			**1.00**

* Includes non-revenue water use

FIGURE 3-1 summarizes the historical annual water production and number of active service connections. The figure demonstrates a correlation between the number of active service connections and the amount of water consumed. The average demand per connection varied between 0.79 and 1.23.

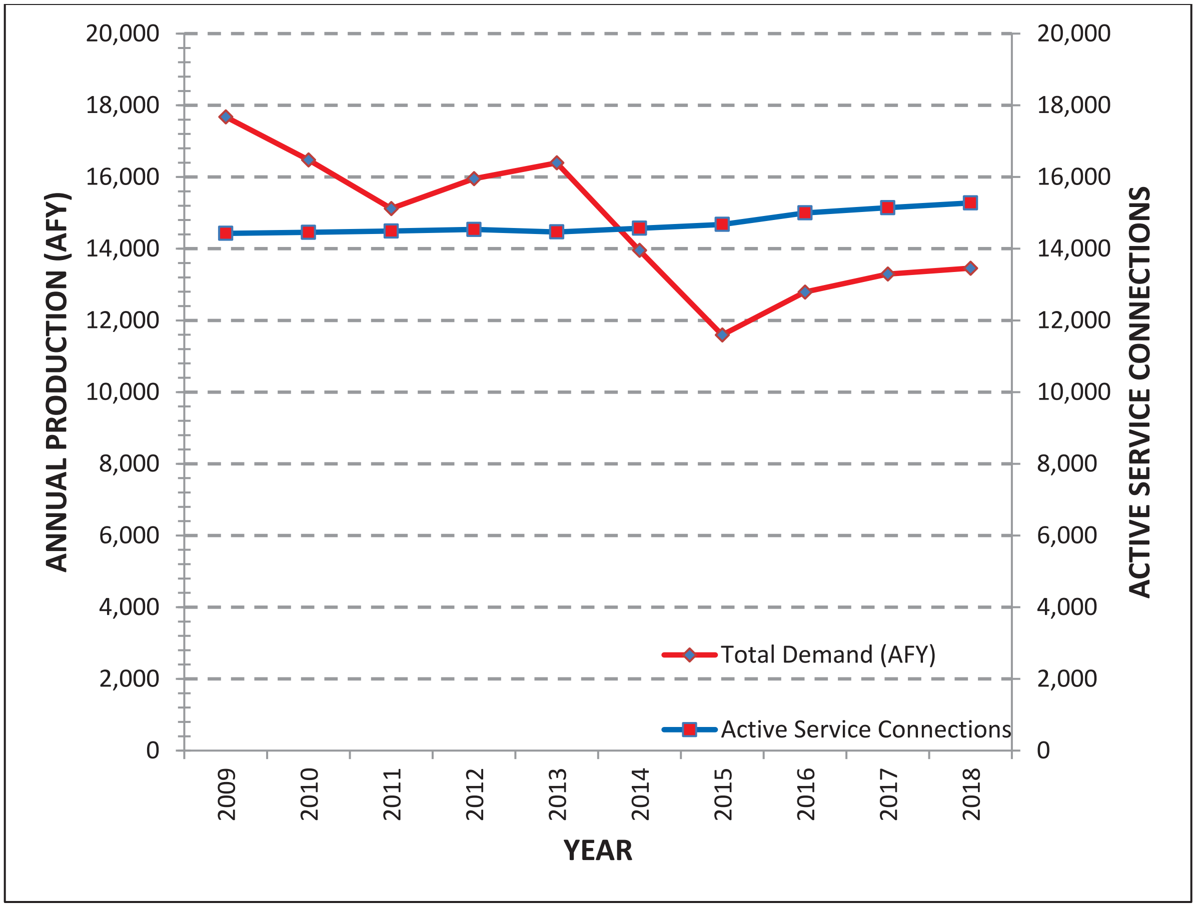


FIGURE 3-1 Historical Annual Production Totals and Active Service Connections for the Last 10 Years

3.2.2 Establishing Demands

The total water demand for existing conditions was estimated by multiplying the number of 2018 active service connections (15,277) with the 10-year average of the average demand per service connection (1.00 AFY/conn.), resulting in a system water demand of 15,274 AFY. Converting the system water demand to a daily demand produces an ADD of 9,469 gpm. This approach allows the calculation of ADD for various planning years, including the impact on anticipated growth, and then allows a direct calculation for other demand periods using the appropriate peaking factor.

To evaluate the system's performance during the MDD scenario, existing historical demand data were used in accordance with the Waterworks Standards set forth by the California Code of Regulations (2009). Section 64554.30 of the Waterworks Standards define MDD as "the amount of water utilized by customers during the highest day of use (midnight to midnight), excluding fire flow, as determined pursuant to Section 64554." Section 64554(b)(1) of the Waterworks Standards states "…identify the day with the highest usage during the past ten years to obtain MDD…". While GSWC is currently unable to track customer usage over an exact 24-hour period, GSWC does record daily water production – and, as stated in Master Plan Section 3.2.1, above, it can be "assumed that the historical water production equal[s] the historical water demand". However, because the daily production reads are not taken at midnight or always collected at the same time each day, the resulting data may be for time periods that can range anywhere from 16 to 32 hours (depending on the time of day the production data are collected). For example, the readings may be taken at 9am one day and 4pm the next; this introduces the chance of a fairly large error if only the recording for a single day is used, as it could include water production over a period longer than 24 hours. To address the possible variations in the hours per day within a given production read, GSWC identifies and uses the average of the three consecutive days with the highest production for each calendar year. By utilizing the average of these highest three consecutive days of water production, the resulting number is normalized, reducing the effect of any imprecision due to the time of day when the data was collected.

Table 3-2 presents the ADD, MDD, and peaking factor data over the last ten years.

TABLE 3-2 Historical Average and Maximum Day Demand

Year	ADD[a]		MDD[b] (gpm)	MDD Peaking Factor (MDD:ADD)
	AFY	gpm		
2009	17,677	10,958	18,176	1.66
2010	16,479	10,215	17,755	1.74
2011	15,120	9,373	15,172	1.62
2012	15,953	9,890	16,528	1.67
2013	16,394	10,163	15,866	1.56
2014	13,954	8,650	14,275	1.65
2015	11,594	7,187	9,955	1.39
2016	12,790	7,929	12,858	1.62
2017	13,293	8,241	13,428	1.63
2018	13,456	8,342	13,353	1.60

[a] Includes non-revenue water use
[b] Average of three consecutive highest days

Peaking factors are typically calculated as a ratio of the demand period to ADD. For example, to determine the MDD peaking factor you would divide the MDD by the ADD. Peaking factors are used to estimate future water demands as presented and discussed in Section 3.3. To determine the existing MDD, the Waterworks Standards state the following in Section 64554(b):

> *A system shall estimate MDD and PHD for the water system as a whole (total source capacity and number of service connections) and for each pressure zone within the system (total water supply available from the water sources and interzonal transfers directly supplying the zone and number of service connections within the zone), as follows:*
>
> *(1) If daily water usage data are available, identify the day with the highest usage during the past ten years to obtain MDD; determine the average hourly flow during MDD and multiply by a peaking factor of at least 1.5 to obtain PHD.*

According to TABLE 3-2, the highest MDD during the past ten years was 18,176 gpm, which occurred in 2009. Multiplying the MDD by a peaking factor of 1.5 results in a PHD of 27,264 gpm. It has been GSWC's experience that utilizing a peaking factor of 1.5 has been sufficient to meet PHD. Projected system demands for the ADD, MDD, and PHD scenarios are summarized in TABLE 3-3.

TABLE 3-3 Projected System Demands by Demand Period

Demand Period	GPM
ADD	9,469
MDD	18,176
PHD	27,264

3.3 Future Demand Projections

Future demands were projected first to estimate future ADD, and then peaking factors were applied to estimate MDD and PHD. The following sources of data and approaches were used:

- Growth-rate projections
- Water-demand projections

3.3.1 Growth Rate Projections

Growth rate projections were obtained from the 2015 Urban Water Management Plan (UWMP) for the Cordova System, and were based on estimates of the number of future service connections. The UWMP methodology used year 2010 U.S. Census data to correlate population growth with the increase in service connections. This correlation was then used to determine future water demand.

3.3.2 Water Demand Projections

The projected annual water demands were obtained from the 2015 UWMP for the Cordova System and are based on the projected number of service connections. A factor for average water demand per connection was then applied, and state-mandated SBX7-7 reductions taken into account.

FIGURE 3-2 presents the historical and projected annual water demands, including the most recent 10-year period. Projections of future demands are slightly higher than the existing demand (2019) of 15,274 AFY.

The State of California is in a long term drought and the Governor has issued Executive Orders that will likely result in significant reductions in future demands. This Master Plan utilizes the current requirements established by the State of California and California Public Utilities Commission in evaluating needed facilities but acknowledges that the requirements may change. Subsequent updates to this Master Plan will reflect future changes in requirements.

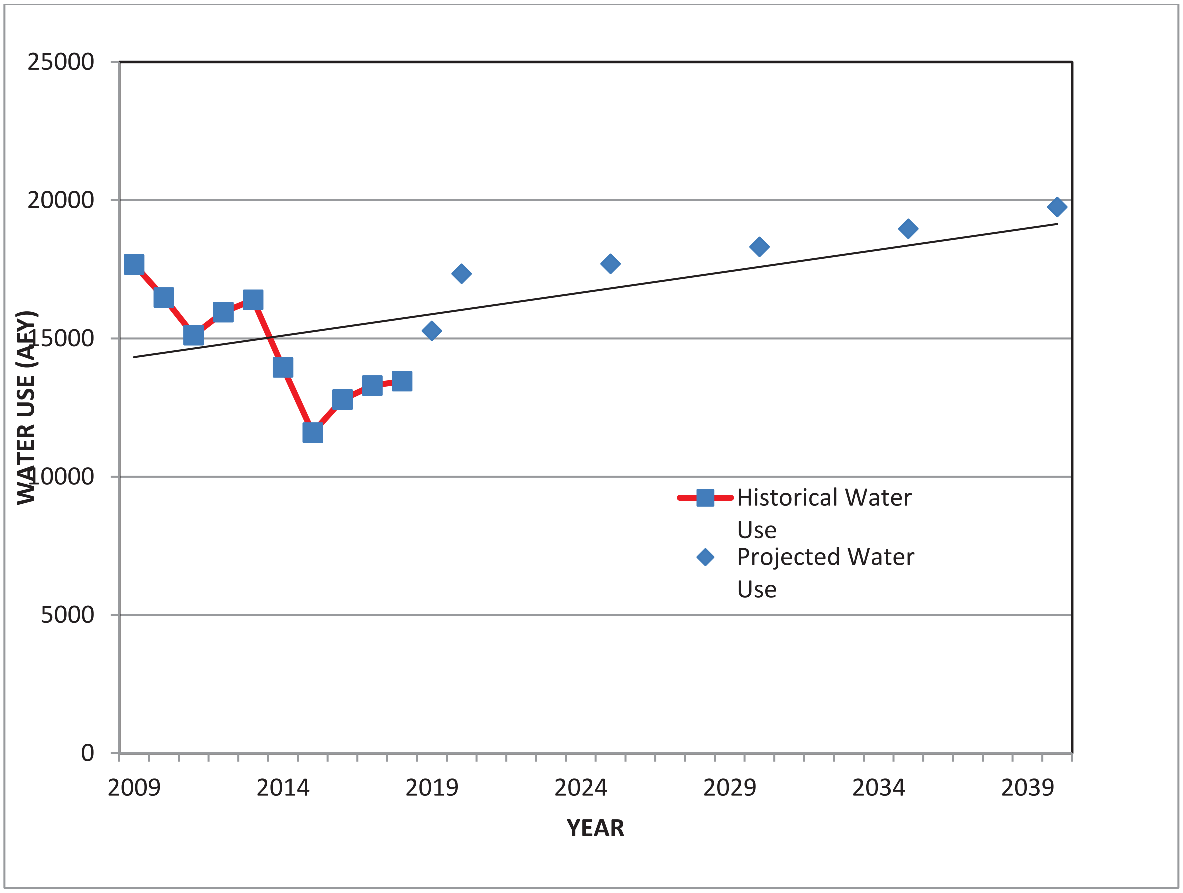


FIGURE 3-2 Historical Water Demand and Future Water Demand Projections

The water demands for 2040 project to be 19,752 AFY, resulting in an ADD of 12,250 gpm. To determine the projected MDD for year 2040, a peaking factor from TABLE 3-2 was applied to the projected ADD. The peaking factor associated with the highest MDD during the past ten years, 1.66 in 2009, was selected, resulting in a MDD of 20,335 gpm. A peaking factor of 1.5 was multiplied by the projected MDD to determine the projected PHD, which is 30,502 gpm. TABLE 3-4 summarizes the projected demands for ADD, MDD, and PHD periods.

TABLE 3-4 Water System Demands by Demand Period

	Demand Period and Peaking Factor			
Planning Year	**Annual Average (AFY)**	**ADD (gpm)**	**MDD (gpm)**	**PHD (gpm)**
2020	17,342	10,755	17,854	26,781
2040	19,752	12,250	20,335	30,502

SECTION 4

Hydraulic Model Development and Calibration

4.1 Overview

A computerized hydraulic model of a water distribution system is an important tool used as part of the Water Master Plan to conduct hydraulic analyses of the water system.

The computer model is used to analyze the facilities, operational characteristics, and water supply and consumption data of a water system. The water distribution system hydraulic model includes pipes, junction nodes (connection points for pipes and location of demands), valves, wells, pumps, purchased water connections, tanks, and reservoirs. Operational characteristics include parameters that control the method by which the water is distributed through the system, such as on and off settings for pumps, pressure or flow controls for hydraulically actuated valves, or main line valve closures. Data for supply and consumption determine where the water supply and demands are applied within the modeled distribution system.

Accurate computer model development begins with entering the correct information into the data file and calibrating the model to match existing conditions in the field. Once this foundation is complete, the resulting model becomes an invaluable tool. It can simulate the existing and future water system, identify system deficiencies, analyze impacts from increased demands, and determine the effectiveness of proposed improvements.

4.2 Construction and Calibration of the Hydraulic Computer Model

The Cordova System hydraulic computer model was revised as part of the 2016 Master Plan. For this Master Plan, the model was checked for accuracy and updated to include newly constructed facilities. Valve settings for pressure regulating valves were also verified, and the system demands were validated. Localized calibration was performed to refine the model in certain sections of the system.

4.3 Summary

This Master Plan update included verification of the physical components represented in the hydraulic model, validation of demands in the model, and localized field testing and calibration.

It is important to note that model calibration for any water system is an ongoing effort. As changes in the system occur from changing demands, new infrastructure development, or changing operational settings, the model must be periodically updated and checked to ensure agreement with field measurements. This update serves as a baseline for future calibration efforts by GSWC.

SECTION 5

Supply and Storage Capacity Evaluation

This section documents the evaluation of the water supply and storage capacity for the Cordova System. The evaluation results accomplished the following:

- Established storage needs for each pressure zone and the entire distribution system
- Identified supply and/or storage deficiencies in the existing and future systems
- Proposed improvements that mitigate the deficiencies identified

In each subsection, the supply and storage capacity of the existing and future water systems were measured against the objectives identified in the technical memorandum titled *Master Planning Criteria and Standards* (see Appendices). When the analysis indicated that the system did not meet these criteria, a deficiency was identified and facilities were proposed to mitigate the deficiency.

5.1 Overview

To provide a reliable water supply, a water system must be able to meet the system demands under a variety of conditions. The water supplied may be provided by a combination of supply sources, or stored water, or both. The specific demand period being analyzed may limit the source of water for the scenario. For example, stored water should not be used to meet ADD or MDD but could be used for PHD or MDD+FF. Therefore, each demand period may require a different ratio of water supplies and storage. This analysis examines various demand periods to determine if the system has the ability to reliably meet the system demands under typical demand scenarios using a combination of water supply sources and storage.

5.2 Evaluation Approach

This supply and storage capacity analysis examined the Cordova System under two planning periods:

- **Existing (2019) system.** The demands for the existing water system were determined by multiplying the 10 year historical average demand per connection and the most recent number of connections (year 2018) to obtain the total system demand. The analyses assumed all facilities that were operational in 2019.

- **2040 system.** The long-term planning horizon (2040) water system analysis assumed 2040 demands (assumed buildout) and facilities included in the existing system analysis plus facilities needed to correct deficiencies in 2040.

5.2.1 Analysis Criteria

The Cordova System must be capable of providing sufficient water supply and storage capacity to meet the minimum criteria summarized in TABLE 5-1. These criteria were extracted from the technical memorandum titled *Master Planning Criteria and Standards*.

The criteria apply to the system as a whole and to each pressure zone in the system. For planning purposes, this Master Plan utilizes the Planning Scenario 'MDD + Fire Flow' to analyze the system performance under a worst-case planning scenario. The worst-case planning scenario is represented by applying the single most stringent fire flow requirement established (based on land use plans or as designated by the local fire jurisdiction) for a structure within a hydraulic zone or planning area as the baseline fire flow requirement for the entire hydraulic zone or planning area. For the purposes of the planning analysis, this is considered a goal rather than a requirement. If the result of the worst case planning scenario indicates a deficiency in MDD + Fire Flow, it should be noted that there may not be a deficiency in the actual fire flow requirement for a particular structure, but rather that GSWC is not meeting the planning goal for the overall hydraulic zone or planning area.

TABLE 5-1 Supply and Storage Capacity Analysis Criteria

Planning Scenario	Demand and Duration	Evaluation Criterion	Storage Usage	Facilities Assumed to be Out of Service
Average day	ADD for 24 hours	Total capacity	No storage drawdown	-
Maximum day	MDD for 24 hours	Firm capacity	No storage drawdown	Largest pumping unit in system
Peak hour	PHD for 4 hours[1]	Firm capacity	Operational storage	Largest pumping unit in system
MDD + fire flow	MDD plus fire flow, duration varies[2]	Total capacity	Fire storage	-

[1] Operational storage required to meet peak demands during MDD was defined as the supply needs during 4 hours of PHD.
[2] Fire flow scenarios are based on fire agency maximum flow requirements for a single structure within a planning area and are applied throughout the planning area as part of the planning analysis. Actual fire flows may be less than the maximum fire flow used for planning analysis.

It is worth noting that the California Public Utilities Commission (CPUC) and State Water Resources Control Board, Division of Drinking Water (DDW) currently provide no specific requirements for storage volume. Therefore, recommended standards published by the American Water Works Association (AWWA) were considered in the development of the storage criteria used in this master plan.

5.2.2 Storage

In addition to providing adequate water supplies for the water consumers, water distribution systems often rely on stored water within the distribution system to provide the following operational benefits:

- Help equalize fluctuations between supply and demand.
- Supply sufficient water for firefighting.
- Meet demands during an emergency or unplanned outage of a major supply source.

AWWA defines three types of storage: operational, fire, and emergency. The amount of storage required for each of these types varies by system. Nevertheless, all three types of storage must be considered. In some cases, water stored in the groundwater basin can provide some of this storage. However, when the stored water does not flow by gravity and requires pumping, sufficient pumping redundancy and stand-by power generators must be provided if the storage source is to be considered reliable.

This analysis evaluates the ability of the system's storage facilities to meet the water system's storage requirements. The resulting volume must be allocated to the pressure zones where the demands exist, or to a neighboring zone (if there are pressure-regulating stations or check valves available that allow the water to flow into the neighboring zone). The water system must also be evaluated to determine if existing booster stations provide sufficient water to be pumped into the higher-pressure zones.

TABLE 5-2 presents the recommended operational, fire, and emergency storage criteria as defined by GSWC for the Cordova System.

TABLE 5-2 Criteria for Calculating Storage

Storage Category	GSWC Criteria
Operational	Storage volume to meet PHD in addition to MDD supply
Fire	Maximum recommended fire storage volume in the system
Emergency	ADD for 12 hours

Operational Storage

The required volume of water for operational storage is determined by the volume needed for regulating the difference between the rate of supply and the daily variations (peaks) in water usage. This difference results in the lowest and highest operating levels in the reservoirs under normal conditions. The resulting volume must be allocated to either the pressure zone (where the demands exist) or to a higher-pressure zone (for use by the lower-pressure zone).

Fire Storage

The volume of water required for firefighting is a function of the instantaneous flow rate required to fight the fire over the duration of the fire flow event as determined by the local fire jurisdiction. Consideration is also made to evaluate the number of fire flow events that may occur before the volume can be replenished. Further, the volume of water necessary to fight a fire can be provided from water supply, water storage, or a combination thereof. For planning purposes, it is desirable and conservative to design the water system to have capacity within water tanks for the volume of water needed for firefighting; however, the fire storage in the tanks plus available supply in excess of MDD can be utilized to meet firefighting requirements. The fire-flow requirements listed in TABLE 5-3 were used to establish the flow rate and duration for each pressure zone; these criteria were used to identify the largest volume of water required for firefighting within each pressure zone (based on the land use in that zone and the flow rates and durations from TABLE 5-3). The resulting fire-flow volumes are shown in TABLE 5-3.

TABLE 5-3 Fire Storage Volumes

Land Use Category	Minimum Fire Flow Required (gpm)	Duration (hr)	Recommended Fire Storage Volume (MG)
Commercial or business	4,000	3	0.72
Public facilities or high school	3,500	3	0.63
Intermediate/elementary school	2,500	2	0.30
Multifamily residential	2,500	2	0.30
Single-family residential	1,500	2	0.18

MG: million gallons

For the Cordova System, it was assumed that only one fire event within the system would occur before storage tanks could recover. The lowest fire-flow volume (0.18 MG) is the result of a 1,500-gpm fire for duration of 2 hours (single-family residential land use). The largest fire-flow volume (0.72 MG) is the result of a 4,000-gpm fire for a duration of 3 hours (commercial or business use).

Emergency Storage

Emergency storage is a dedicated source of water that can be used as a backup supply in the event a major supply source is interrupted. This can be provided by water from a second independent source, by water stored in reservoirs, or a combination of both. *Ten States Standards* recommends that emergency storage total between 12 and 24 hours of ADD volume. Because the Cordova System contains multiple supply sources and a storage reservoir, 12 hours of ADD volume for this system is appropriate.

5.3 Existing System Evaluation

Evaluation of the existing system's supply and storage capacity involved analysis of key system facilities to identify supply or storage capacity deficiencies. This approach involved analyzing multiple proposed improvement alternatives to address these deficiencies. These proposed improvements were then evaluated to determine the most cost-effective alternatives, which would then be identified as the recommended improvements and incorporated into the CIP. The following subsections describe the existing system evaluation:

- Water demands for each demand period
- Supply facilities
- Storage facilities
- Capacity analysis
- Proposed improvements to address deficiencies in the existing system

5.3.1 Existing System Water Demands for Each Demand Period

TABLE 5-4 defines the existing demands by pressure zone for each demand period. The demand in the East Zone is assumed to be 34 percent of the total demand, and the demand in the West Zone is assumed to be 66 percent of the total demands, which are based on spatial demand allocation data from the Cordova GIS.

TABLE 5-4 Existing System Water Demands

Pressure Zone	ADD (gpm)	MDD (gpm)	PHD (gpm)	Demand by Zone (%)
East Zone	3,266	6,269	9,404	34
West Zone	6,203	11,906	17,860	66
Total	**9,469**	**18,176**	**27,264**	**100**

5.3.2 Existing System Supply Facilities

The existing water supply facilities in the Cordova System were identified in Section 2, Existing Water System Facilities. TABLE 5-5 summarizes the design production capacity of each supply source and systemwide totals for total capacity and firm capacity.

TABLE 5-5 Existing System Supply Facilities

Facility Name	Source	Pressure Zone	Total Capacity (gpm)
Agnes #8	Groundwater	West Zone	500
Capital #23[a]	Groundwater	West Zone	-
Dolecetto #6	Groundwater	West Zone	750
Mather#18	Groundwater	West Zone	1,800
Paseo #24	Groundwater	West Zone	1,050
Carmichael Water District	Interconnection	West Zone	3,125
Coloma #20[c]	Groundwater	East Zone	2,500
Park #17	Groundwater	East Zone	1,400
S. Bridge St. 22A[b]	Groundwater	East Zone	3,200
S. Bridge St. 22B	Groundwater	East Zone	2,800
Coloma Treatment Plant[c]	Surface Water	East Zone	7,680
Pyrites Treatment Plant[c]	Surface Water	East Zone	3,500
Systemwide total			**28,305**

[a] As stated in Table 2-3, this well is currently out of service and work is underway to determine/update well capacity; as such, this well is not included as available supply capacity in the system analyses below.
[b] This supply source represents the largest capacity facility in the system and was therefore assumed to be unavailable for firm capacity.
[c] Surface water from Folsom South Canal is treated at the Coloma and Pyrites Treatment Plants; this water is considered a reliable supply source, and the Plants are not considered when determining firm capacity. Actual supply capacity from the Coloma Treatment Plant, Pyrites Treatment Plant, and Coloma Well #20 is the lesser of: 1) the combined total capacity of the three facilities; or 2) the booster capacity of the Plant, as water from all three facilities is re-boosted before entering the distribution system.

5.3.3 Existing System Storage Facilities

The existing storage facilities in the Cordova System are described in Section 2, Existing Water System Facilities. TABLE 5-6 summarizes the storage facilities for the Cordova System.

TABLE 5-6 Existing System Storage Facilities

Facility Name	Primary Pressure Zone Served	Total Capacity (MG)
Coloma #1	East Zone	1.00
Coloma #2	East Zone	1.00
Coloma #3	East Zone	2.00
Coloma #4	East Zone	5.00
Stone Creek Reservoir	West Zone	5.00
Oselot Tank	West Zone	0.50
Total storage capacity		**14.50***

* 13.3 MG is available for the distribution system. For further detail, see Table 2-6.

5.3.4 Existing System Supply and Capacity Analysis

This analysis of the existing water distribution system evaluated the two pressure zones separately and then the system as a whole to verify that adequate supply and storage facilities were available. The analysis reviewed the demand periods (ADD, MDD, PHD, MDD+FF and both planned and unplanned MWD outages); the duration for each demand period is detailed in TABLE 5-1. The duration of MDD+FF was established by the fire-flow criteria identified in TABLE 5-3.

In the following subsections, an analysis is performed for each pressure zone and for the overall system. The demands and production capacities for each zone are presented in a table that summarizes the results. These tables present the demands for each demand period in the zone and for any zones that depend on this zone for supplies. These demands are presented as a flow rate and are converted into a demand volume using the duration for the demand period. For example, a demand of 100 gpm for ADD would be equal to a demand volume of 144,000 gallons, given that the duration of ADD is 24 hours.

Available supplies are presented below the demand volume totals. Available supplies include water supply sources, booster pumping capacity, and stored water. Stored water was not used to provide water supplies during ADD or MDD. Stored water that was allocated as operational storage was assumed to be available for PHD, and water stored for fire flows was assumed to be available for MDD+FF. The total supplies were assumed to be available for ADD and MDD+FF. For the purpose of assuring reliable water service is provided to customers, each zone's ability to meet MDD and PHD with firm capacity was analyzed. (Firm capacity was defined as the available capacity with the largest pumping unit out of service.) The available production was calculated by converting flow rates into a production volume (using the duration of the demand period) and adding the available storage volume.

The last two lines of the table compare the system's available production capacity to the demands for the same duration. Where production capacity exceeds demands, the row *supply minus demand* will be positive. This indicates an adequate combination of supplies and storage. Where this occurs, the last row of the table, *supply meets demand*, will contain *yes*. However, if demands exceed production, then the row *supply minus demand* will have a negative value, and the row *supply meets demand* will contain *no*. In this latter case, proposed improvements were evaluated to correct the deficiency.

Cordova East Zone Analysis

Water supply to the Cordova East Zone is provided by four active wells and treated water from the Coloma and Pyrites Treatment Plants, as listed in TABLE 5-5. South Bridge Street Well 22A is the largest source of capacity for the East Zone, so it was assumed to be unavailable for firm capacity. There is 9.0 MG storage in East Zone, but 1.2 MG is dedicated to CT requirements, which leaves 7.8 MG available for system storage. Supply from the Treatment Plants, Coloma Well #20, and the Coloma Reservoirs are re-boosted before entering the distribution system, and are therefore accounted for by the Coloma boosters, as listed in TABLE 5-7. Fire flow was assumed to occur at only one place at a given time, and the maximum fire flow (0.30 MG) was assumed.

The overall capacity analysis for the East Zone is presented in TABLE 5-7.

TABLE 5-7 Existing System Supply and Capacity Analysis—East Zone

		Planning Scenario							
		ADD		**MDD**		**PHD**		**MDD+FF**	
Duration (Hours)		24		24		4		2	
Demand		GPM	MG	GPM	MG	GPM	MG	GPM	MG
East Zone		3,266	4.703	6,269	9.028	9,404	2.257	8,769	1.052
West Zone	PRV	0	0.000	4,681	6.741	4,675	1.122	681	0.082
Total Demand		**3,266**	**4.703**	**10,951**	**15.769**	**14,079**	**3.379**	**9,450**	**1.134**
Supply	Capacity								
Wells	7,400	7,400	10.656	4,200	6.048	4,200	1.008	7,400	0.888
Connections	N/A	-	-	-	-	-	-	-	-
Boosters	24,000	2,500	3.600	6,751	9.721	9,879	2.371	2,500	0.300
PRVs	N/A	-	-	-	-	-	-	-	-
Reservoirs	-	-	-	-	-	-	-	-	-
Total Supply		**9,900**	**14.256**	**10,951**	**15.769**	**14,079**	**3.379**	**9,900**	**1.188**
Supply Minus Demand		**6,634**	**9.553**	**0**	**0.000**	**0**	**0.000**	**450**	**0.054**
Supply Meets Demand		**YES**		**YES**		**YES**		**YES**	

		Planning Scenario					
		Planned CWD outage		Unplanned Outage - Day 1 (MDD)		Unplanned Outage - Days 2-7 (ADD)	
Duration (Hours)		168		24		144	
Demand		GPM	MG	GPM	MG	GPM	MG
East Zone		3,266	32.922	6,269	9.028	3,266	28.219
West Zone	PRV	2,103	21.196	4,681	6.741	2,103	18.168
Total Demand		**5,369**	**54.118**	**10,951**	**15.769**	**5,369**	**46.387**
Supply	Capacity						
Wells	7,400	7,400	74.592	7,400	10.656	7,400	63.936
Connections	N/A	-	-	-	-	-	-
Boosters	24,000	2,500	25.200	3,551	5.113	2,500	21.600
PRVs	N/A	-	-	-	-	-	-
Reservoirs	-	-	-	-	-	-	-
Total Supply		**9,900**	**99.792**	**10,951**	**15.769**	**9,900**	**85.536**
Supply Minus Demand		**4,531**	**45.674**	**0**	**0.000**	**4,531**	**39.149**
Supply Meets Demand		**YES**		**YES**		**YES**	

The existing system supply and storage capacity analysis results indicate that facilities are adequate to meet the demands for all planning scenarios.

Cordova West Zone Analysis

Water supply to the Cordova West Zone is provided by five active wells, treated water from the Carmichael Water District Interconnection, and five PRVs from the East Zone, as listed in TABLE 5-8. Capital Well #23 is the largest source of capacity for the West Zone, so it was assumed to be unavailable for firm capacity. There is 5.5 MG of storage; the Oselot Tank (5.0 MG) is accounted for by the Oselot boosters in Table 5-8. Fire flow was assumed to occur at only one place at a given time, and the maximum fire flow (0.72 MG) was assumed.

The overall capacity analysis for the West Zone is presented in TABLE 5-8.

TABLE 5-8 Existing System Supply and Capacity Analysis—West Zone

		Planning Scenario							
		ADD		MDD		PHD		MDD+FF	
Duration (Hours)		24		24		4		3	
Demand		GPM	MG	GPM	MG	GPM	MG	GPM	MG
West Zone		6,203	8.932	11,906	17.145	17,860	4.286	15,906	2.863
Total Demand		**6,203**	**8.932**	**11,906**	**17.145**	**17,860**	**4.286**	**15,906**	**2.863**
Supply	Capacity								
Wells	6,300	4,100[a]	5.904	2,300	3.312	2,300	0.552	4,100	0.738
Connections	3,125	3,125	4.500	3,125	4.500	3,125	0.750	3,125	0.563
Boosters	7,750	0	0.000	0	0.000	5,960	1.430	4,000	0.720
PRVs	26,350	0	0.000	6,481	9.333	6,475	1.554	4,681	0.843
Reservoirs	0.5	-	-	-	-	-	-	-	-
Total Supply		**7,225**	**10.404**	**11,906**	**17.145**	**17,860**	**4.286**	**15,906**	**2.863**
Supply Minus Demand		**1,022**	**1.472**	**0**	**0.000**	**0**	**0.000**	**0**	**0.000**
Supply Meets Demand		**YES**		**YES**		**YES**		**YES**	

		Planning Scenario					
		Planned CWD outage		Unplanned Outage - Day 1 (MDD)		Unplanned Outage - Days 2-7 (ADD)	
Duration (Hours)		168		24		144	
Demand		GPM	MG	GPM	MG	GPM	MG
West Zone		6,203	62.524	11,906	17.145	6,203	53.592
Total Demand		**6,203**	**62.524**	**11,906**	**17.145**	**6,203**	**53.592**
Supply	Capacity						
Wells	6,300	4,100	41.328	4,100	5.904	4,100	35.424
Connections	3,125	0	0.000	0	0.000	0	0.000
Boosters	7,750	0	0.000	3,125	4.500	0	0.000
PRVs	26,350	2,103	21.196	4,681	6.741	2,103	18.168
Reservoirs	0.5	0	0.000	0	0.000	0	0.000
Total Supply		**6,203**	**62.524**	**11,906**	**17.145**	**6,203**	**53.592**
Supply Minus Demand		**0**	**0.000**	**0**	**0.000**	**0**	**0.000**
Supply Meets Demand		**YES**		**YES**		**YES**	

[a] Capital Well #23 is currently out of service, and therefore not included in available supply capacity.

The existing system supply and storage capacity analysis results indicate that facilities are adequate to meet the demands for all planning scenarios.

Systemwide Capacity Analysis

In the systemwide analysis, all supply and storage facilities were included. The total existing demands were presented in TABLE 5-4. The total and firm production capacities in TABLE 5-5 and the storage facilities in TABLE 5-6 were used for the appropriate demand periods. The fire flow used for MDD+FF was based on the largest fire flow in the system, a 4,000-gpm fire flow for 3-hour duration.

The results of the systemwide supply and storage analysis for the existing system are summarized in TABLE 5-9.

TABLE 5-9 Existing System Supply and Capacity Analysis—Systemwide

		Planning Scenario							
		ADD		MDD		PHD		MDD+FF	
Duration (Hours)		24		24		4		3	
Demand		GPM	MG	GPM	MG	GPM	MG	GPM	MG
Total Demand		**9,469**	**13.635**	**18,176**	**26.173**	**27,264**	**6.543**	**22,176**	**3.992**
Supply	Capacity								
Wells	13,700	11,500[a]	16.560	8,300	11.952	8,300	1.992	11,500	2.070
Connections	3,125	3,125	4.500	3,125	4.500	3,125	0.750	3,125	0.563
Boosters	31,750	2,500	3.600	6,751	9.721	15,839	3.801	7,550	1.359
Reservoirs	0.5	-	-	-	-	0	0.000	0	0.000
Total Supply		**17,125**	**24.660**	**18,176**	**26.173**	**27,264**	**6.543**	**22,175**	**3.992**
Supply Minus Demand		**7,656**	**11.024**	**0**	**0.000**	**0**	**0.000**	**0**	**0.000**
Supply Meets Demand		**YES**		**YES**		**YES**		**YES**	

		Planning Scenario					
		Planned CWD outage		Unplanned Outage - Day 1 (MDD)		Unplanned Outage - Days 2-7 (ADD)	
Duration (Hours)		168		24		144	
Demand		GPM	MG	GPM	MG	GPM	MG
Total Demand		**9,469**	**95.446**	**18,176**	**26.173**	**9,469**	**81.811**
Supply	Capacity						
Wells	13,700	11,500	115.920	11,500	16.560	11,500	99.360
Connections	3,125	0	0.000	0	0.000	0	0.000
Boosters	31,750	2,500	25.200	6,676	9.613	2,500	21.600
Reservoirs	0.5	0	0.000	0	0.000	0	0.000
Total Supply		**14,000**	**141.120**	**18,176**	**26.173**	**14,000**	**120.960**
Supply Minus Demand		**4,531**	**45.674**	**0**	**0.000**	**4,531**	**39.149**
Supply Meets Demand		**YES**		**YES**		**YES**	

[a] Capital Well #23 is currently out of service, and therefore not included in available supply capacity.

The systemwide supply and storage analysis results for the existing system indicate that the existing supply meets the demands for all planning scenarios.

5.3.5 Existing System Storage Analysis

The analysis of the existing storage facilities evaluated the required storage for each pressure zone and compared it to the existing storage available for each zone to determine the storage deficiencies. The benefits of storage and the types of storage (operational, fire, and emergency) are described in more detail in section 5.2.2.

TABLE 5-10 evaluates the three types of storage to calculate the total required storage for each zone and the entire system. The operational storage is calculated by subtracting the MDD from the PHD to obtain the additional flowrate that is required during the PHD scenario. This additional flowrate is multiplied by the duration of PHD and then converted to a volume to determine the required operational storage. A duration of four hours was used to account for the typical duration of peak demands during the day. The fire storage for each zone is based on criteria given in section 5.2.2. In cases where two or more pressure zones retain their fire storage in the same reservoir, that reservoir only needs to contain the fire storage for the zone with the largest recommended fire storage volume. This is because the criteria consider only one fire flow can occur in the system at any given time. To prevent accounting for excess fire storage, pressure zones were given a fire storage total of 0 MG in TABLE 5-10 when fire storage of larger or equal size was used in another zone that retains its fire storage in the same tank. The emergency storage is the volumetric measurement of the ADD over a duration of 12 hours.

Storage deficiencies are identified for each zone in TABLE 5-11. All tanks in the existing system are listed in the left column of the table. All pressure zones in the existing system are listed in the top row of the table. The numbers in the table represent the allotted amount of storage, in millions of gallons, for each zone from each tank. A dash in the table denotes storage from that tank is unavailable for that zone. Zones that are able to utilize storage in a tank, but are not allotted any storage from it are shown in the table as zero. Summing the numbers across the rows results in the total storage volume of the tank listed in the left column of that row. Summing the numbers going down the columns results in the available storage for the zone listed in the top row of that column. The required storage, taken from TABLE 5-10, is given in the row below the available storage. Subtracting the required storage from the available storage within a column results in the excess storage for that column's zone. Negative numbers imply a storage deficiency and are given a "NO" in the adequate storage column. A "YES" in the adequate storage column implies there is adequate storage available for that zone. Fire storage is calculated to supplement supply when the supply is less than the current demand plus fire flow (see Section 5.3.4). Fire storage requirements are planning standards and fire storage is typically only required in times of high demands, supply limitations, and/or emergencies.

TABLE 5-10 Existing System Storage Analysis - Calculated Storage

	Zones		
	East Zone	West Zone	**Systemwide**
Operational			
PHD	9,404	17,860	27,264
MDD	6,269	11,906	18,176
PHD minus MDD	3,135	5,953	9,088
Duration	4.00	4.00	4.00
MG	0.75	1.43	2.18
Fire			
GPM	2,500	4,000	-
Duration	2.00	3.00	-
MG*	0.30	0.72	1.02
Emergency			
ADD	3,266	6,203	9,469
Duration	12.00	12.00	12.00
MG	2.35	4.47	6.82
Total Recommended Storage	**3.40**	**6.61**	**10.02**

* For the Cordova System, a portion of the West Zone fire storage (2,500 gpm) may be supplied from the East Zone via PRVs, reducing the total storage required in the West Zone from 0.72 MG to 0.44 MG.
NOTE: All demand period scenarios (ADD, MDD, and PHD) are given in gallons per minute (GPM). All durations are given in hours. The rows titled "MG" and the total required storage are given in million gallons (MG).

TABLE 5-11 Existing System Storage Analysis - Adequacy Evaluation

	Zones		
	East Zone	West Zone	Total
Coloma Tanks	7.800	-	**7.800**
Stone Creek Reservoirs	-	0.500	**0.500**
Oselot Tank	-	5.000	**5.000**
Available Storage	7.800	5.500	**13.300**
Recommended Storage*	3.404	6.615	**10.019**
Available Minus Recommended	4.396	-1.115	3.281
Adequate Storage	**YES**	**NO**	**YES**

* Recommended Storage numbers are from Table 5-10
NOTE: All numbers given are in million gallons (MG)

The existing system storage analysis results indicate no overall storage deficiency.

5.3.6 Proposed Improvements to Address Deficiencies in the Existing System

Various alternatives were considered while investigating improvements to correct the deficiencies identified in the supply and storage evaluation; these are listed in TABLE 5-12. Deficiencies may be corrected by adding supply, storage, or a combination of both. In these cases, the deficiency is shown in both supply (gpm) and storage (MG). The descriptions of the deficiency alternatives are given at the end of TABLE 5-12.

There were no deficiencies identified in the supply and storage evaluation.

The numbering system used in TABLE 5-12 is a series of three numbers. The first number indicates the planning period: 1 for the existing system and 2 for the 2040 system. The second number indicates the deficiency number, which starts at 1 and increments by 1 for each deficiency identified. The third number identifies the improvement alternative, but zero is reserved for the deficiency. Therefore, the alternative number 1.2.3 would be used to identify the third proposed alternative for the second deficiency in the existing system.

TABLE 5-12 Existing System Proposed Supply and Storage Improvements

Deficiency/ Alternative Number	Deficiency/Alternative Description	Pressure Zone	Supply Capacity (gpm)	Storage Capacity (MG)
-	-	-	-	-

5.3.7 Recommended Improvements to Address Deficiencies in the Existing System

No deficiencies were identified in the Cordova System.

TABLE 5-13 Existing System Recommended Supply and Storage Improvements

Alternative Number	Alternative Description	Deficiencies Resolved	Supply/Storage Capacity
-	-	-	-

5.4 2040 System Evaluation

Analysis of the water system for the year 2040 was performed to identify long-term improvements needed for the water system at buildout. This analysis included the following assumptions:

- Existing supply sources would remain active or be replaced in kind.
- Planned improvements to address existing system deficiencies plus the post-2016 improvements are operational.
- The demands developed in Section 3, Existing and Future Water Demands, were assumed for the respective demand periods.

5.4.1 2040 System Water Demands for Each Demand Period

TABLE 5-14 defines the 2040 demands for the Cordova System. The demands are not provided for each pressure zone because it is unknown how much each zone's demands will increase by the year 2040.

TABLE 5-14 2040 System Water Demands

	ADD (gpm)	MDD (gpm)	PHD (gpm)
Systemwide	12,250	20,335	30,502

5.4.2 2040 System Supply Facilities

The supply facilities for the 2040 system include all supply facilities in the existing system along with all recommended supply facilities to resolve the existing system's deficiencies. TABLE 5-15 summarizes the supply for the 2040 System.

TABLE 5-15 2040 System Assumed Supply Facilities

Facility Name	Total Capacity (gpm)
Additional facilities in the 2040 System	0
Existing supply – Wells, Treatment Plants and CWD Interconnection	30,505
Total production capacity for 2040	**30,505**

5.4.3 2040 System Storage Facilities

The storage facilities for the 2040 system include all storage facilities in the existing system along with all recommended storage facilities to resolve the existing system's deficiencies. TABLE 5-16 summarizes the storage for the 2040 System.

TABLE 5-16 2040 System Assumed Storage Facilities

Facility Name	Primary Pressure Zone Served	Total Capacity (MG)
Recommended storage facilities	Systemwide	0
Existing storage	Systemwide	13.3
Total storage capacity		**13.3**

5.4.4 2040 System Capacity Analysis

The supply analysis for the 2040 system uses the 2040 projected demands and includes the recommended 2040 supply improvements to analyze system deficiencies. An analysis is not given for each pressure zone because it is unknown how much each zone's demands will increase by year 2040. The supply analysis is given in TABLE 5-17.

TABLE 5-17 2040 System Supply and Capacity Analysis—Systemwide

		Planning Scenario							
		ADD		MDD[a]		PHD[b]		MDD+FF	
Duration (Hours)		24		24		4		3	
Demand		GPM	MG	GPM	MG	GPM	MG	GPM	MG
Total Demand		**12,250**	**17.640**	**20,335**	**29.282**	**30,502**	**7.321**	**24,335**	**4.380**
Supply	Capacity								
Wells	13,700	13,700	19.728	10,500	15.120	10,500	2.520	13,700	2.466
Connections	3,125	3,125	4.500	3,125	4.500	3,125	0.750	3,125	0.563
Boosters	31,750	0	0.000	6,710	9.662	16,877	4.050	7,510	1.352
Reservoirs	0.5	-	-	-	-	0	0.000	0	0.000
Total Supply		**16,825**	**24.228**	**20,335**	**29.282**	**30,502**	**7.320**	**24,335**	**4.380**
Supply Minus Demand		**4,575**	**6.588**	**0**	**0.000**	**0**	**0.000**	**0**	**0.000**
Supply Meets Demand		**YES**		**YES**		**YES**		**YES**	

		Planning Scenario					
		Planned CWD outage		Unplanned Outage - Day 1 (MDD)		Unplanned Outage - Days 2-7 (ADD)	
Duration (Hours)		168		24		144	
Demand		GPM	MG	GPM	MG	GPM	MG
Total Demand		**12,250**	**123.479**	**20,335**	**29.282**	**12,250**	**105.839**
Supply	Capacity						
Wells	13,700	13,700	138.096	13,700	19.728	13,700	118.368
Connections	3,125	0	0.000	0	0.000	0	0.000
Boosters	31,750	0	0.000	6,635	9.554	0	0.000
Reservoirs	0.5	0	0.000	0	0.000	0	0.000
Total Supply		**13,700**	**138.096**	**20,335**	**29.282**	**13,700**	**118.368**
Supply Minus Demand		**1,450**	**14.617**	**0**	**0.000**	**1,450**	**12.529**
Supply Meets Demand		**YES**		**YES**		**YES**	

[a] Table 5-18 indicates that there is 1.32 MG 'excess' storage capacity for the Cordova System; in Table 5-17, this excess capacity is utilized to satisfy PHD. Of the 1.32 MG, 0.5 MG is stored in Stone Creek Reservoir; this leaves 0.82 MG that may come from the Oselot Tank or Coloma Reservoirs, both of which are accounted for in Table 5-17 by the booster capacity of their respective plant sites. Any necessary additional supply can then met by Stone Creek Reservoir after the capacities of these plants have been utilized.

[b] In order to satisfy PHD, the boosters are providing a combination of supply from Coloma Well #20, Coloma Treatment Plant, Pyrites Treatment and operational storage.

The systemwide supply and storage analysis results for the 2040 system indicate that the supply meets the demands for all planning scenarios.

5.4.5 2040 System Storage Analysis

The storage analysis for the 2040 system uses the 2040 projected demands and includes the recommended supply and storage improvements for the existing system to analyze system deficiencies. Like the 2040 supply analysis, each pressure zone is not analyzed because it is unknown how much each zone's demands will increase by year 2040. The storage analysis is given in TABLE 5-18.

TABLE 5-18 2040 System Storage Analysis

Scenario		Systemwide
Operational	PHD	30,502
	MDD	20,335
	PHD minus MDD	10,167
	Duration	4
	MG	2.440
Fire	GPM	4,000
	Duration	3
	MG*	0.720
Emergency	ADD	12,250
	Duration	12
	MG	8.820
Total Recommended Storage		11.980
Available Storage in 2040		13.300
Available minus Recommended		1.320
Adequate Storage		YES

The 2040 system storage analysis results indicate no storage deficiency.

5.4.6 Proposed Improvements to Address Deficiencies in the 2040 System

No deficiencies were identified for the 2040 system, as shown in TABLE 5-19.

TABLE 5-19 2040 System Proposed Supply and Storage Improvements

Deficiency/ Alternative Number	Deficiency/Alternative Description	Pressure Zone	Supply Capacity (gpm)	Storage Capacity (MG)
-	-	-	-	-

5.4.7 Recommended Improvements to Address Deficiencies in the 2040 System

No deficiencies were identified for the 2040 system, as shown in TABLE 5-20.

TABLE 5-20 2040 System Recommended Supply and Storage Improvements

Alternative Number	Alternative Description	Deficiencies Resolved	Supply/Storage Capacity
-	-	-	-

5.5 Summary of Proposed Supply and Storage Improvements through 2040

According to the supply and capacity analysis results in this Master Plan, the following additional supply is necessary to meet future demands:

- Existing system: no additional supply
- 2040 system: no additional supply

According to the storage analysis results in this Master Plan, the following additional storage is necessary to meet future demands:

- Existing system: no additional storage
- 2040 system: no additional storage

No storage or supply deficiencies were identified for the existing system or the 2040 system.

The supply and storage improvements planned by GSWC and analyzed in these evaluations are further examined in Section 6, Hydraulic Analysis and Evaluation. The hydraulic analysis helps determine the optimal configuration of improvements to provide maximum operational and cost benefit, and any resulting recommended improvements are incorporated into the CIP.

SECTION 6

Hydraulic Analysis and Evaluation

This section documents the hydraulic analysis and evaluation results for the Cordova System. The hydraulic analysis used the calibrated computer model to evaluate the existing water system. This analysis and evaluation accomplished the following tasks:

- Summarized the criteria for the hydraulic analysis
- Performed simulations for various demand conditions and demand periods
- Analyzed the modeling results to identify deficiencies
- Analyzed various proposed improvements to investigate ways to mitigate these deficiencies
- Developed a list of recommended improvements that provide a cost-effective means to correct deficiencies

In following sections, the hydraulic analysis results of the existing water system were compared with the objectives identified in the technical memorandum titled *Master Planning Criteria and Standards* (see Appendices). When the analysis indicated that the system did not meet these criteria, a deficiency was identified and improvements were proposed to mitigate the deficiency.

6.1 Overview

Hydraulic analyses of networked water distribution systems are most efficiently performed with the aid of hydraulic computer models and specialized software that perform the numerical analysis. The hydraulic computer model assists with measuring system performance, analyzing operational improvements, and developing a systematic method of determining the size and timing required for new facilities. The model can be used to analyze existing water systems, future water systems, and the effect of specific improvements. By analyzing numerous planning scenarios relatively quickly and easily, the model provides answers to several "what if" questions. The computer program analyzes all of the information in the system data file and generates results in terms of pressures, flow rates, and operating status. The key to successfully using the computer model is correct interpretation of these results, and understanding how the water distribution system was affected.

6.2 Analysis Approach

This hydraulic analysis examined the Cordova System for only one planning period:

- **Existing (2019) system.** The existing water system analyses assumed 2019 demands, as described in Section 3, and facilities that were operational in 2019.

The demands used in this hydraulic analysis are the same as used for the supply and storage capacity analysis in Section 5.

6.2.1 System Performance Criteria

Hydraulic analysis of the water system involved the use of a computer model that was developed specifically for the Cordova System and calibrated to conditions observed in the field (see Section 4, Hydraulic Model Development and Calibration). This computer model was used to identify hydraulic deficiencies under the existing planning scenario. Hydraulic model simulations were developed to analyze demand periods (ADD, MDD, PHD, and MDD+FF) to determine whether the system could meet the performance objectives identified for this master plan. These criteria are summarized in TABLE 6-1.

TABLE 6-1 Hydraulic Analysis Criteria

Demand Period	Pipeline Criteria[a]	Pressure Criteria[b]
ADD	Velocity less than 5 fps and head loss less than 6 ft per 1,000 ft	Greater than 40 psi and less than 125 psi
MDD	Velocity less than 5 fps and head loss less than 6 ft per 1,000 ft	Greater than 40 psi and less than 125 psi
PHD	Velocity less than 10 fps	Greater than 30 psi and less than 125 psi
MDD + fire flow	Velocity less than 10 fps	Greater than 20 psi

[a] If velocity or headloss in a pipeline exceeded the criteria listed but did not result in low pressures in the system, the pipeline was not recommended for replacement due to hydraulic deficiencies alone.
[b] Pressure criteria apply only at service connections.

6.2.2 Fire-flow Requirements

In addition to providing adequate water supply and pressure to serve residential, commercial, and industrial water demands placed on the system, the water system must also deliver an adequate supply for firefighting. Since fires can occur at any time, the water system must be ready to provide the required flow at all times with an adequate residual pressure. The water system should be capable of providing the fire flows during an MDD period (MDD+FF), which represents the day of the year having the highest water demands.

To determine the system’s capacity to provide adequate fire flows, it was necessary to establish minimum fire-flow demand requirements to be applied to various locations throughout the distribution system, as well as a minimum residual pressure (the pressure near the flowing hydrant) and system pressure. The local agency responsible for establishing fire-flow requirements for the Cordova System service area is the Sacramento Metropolitan Fire District, which were presented in the previous section in TABLE 5-3.

6.3 Existing System Hydraulic Analysis

Several hydraulic computer model simulations were conducted for the existing distribution system to identify system and operational deficiencies, and to evaluate system improvements to mitigate these deficiencies. If more than one alternative was possible to mitigate a deficiency, the most cost-effective and constructible improvement was recommended.

6.3.1 Operational Assumptions

GSWC operations staff provided information on how the Cordova System would normally be operated under ADD, MDD, and PHD periods. Based on this information, the facilities available for the hydraulic analysis of the existing system are presented in TABLE 6-2. (Note: The status of wells, booster pumps and storage tanks were not based on the model results, but on the amount of supply needed for each demand period. For ADD, there is flexibility to operate various combinations of wells, as not all of the wells need to be operational to achieve the desired pressures; for MDD and PHD scenarios, firm capacity must be used.)

TABLE 6-2 Existing System Operating Facility Status

Facility Name	ADD	MDD	PHD
Wells—West Zone			
Agnes #8	Available	On	On
Capital #23	Off	Off	Off
Dolecetto #6	Available	On	On
Mather #18	Available	On	On
Paseo #24	Available	On	On
CWD Interconnection	On	On	On
Wells—East Zone Zone			
Coloma #20	Available	Off	Off
Park #17	Available	On	On
S. Bridge St. 22A	Available	Off	Off
S. Bridge St. 22B	Available	On	On
Coloma Treatment Plant	Available	On	On
Pyrites Treatment Plant	Available	On	On
Booster pumps			
Coloma Booster A	Available	Off	On
Coloma Booster B	Available	Off	Off
Coloma Booster C	Available	On	On
Coloma Booster D	Available	On	On
Coloma Booster E	Available	On	On
Coloma Booster F	Available	On	On
Coloma Booster G	Available	On	On
Coloma Booster H	Available	On	On
Coloma Booster I	Available	On	On
Oselot Booster 1	Available	Off	On
Oselot Booster 2	Available	Off	On
Oselot Booster 3	Available	Off	Off
Oselot Booster 4	Available	Off	Off
Oselot Booster 5	Available	Off	On
Storage tanks			
Coloma #1	75%	75%	75%
Coloma #2	75%	75%	75%
Coloma #3	75%	75%	75%

Facility Name	ADD	MDD	PHD
Coloma #4	75%	75%	75%
Stone Creek Reservoir	75%	75%	75%
Oselot Tank	75%	75%	75%

6.3.2 Average Day Scenario Analysis

To analyze the average day scenario for the existing system, simulations were performed using the computer model with ADD. The demands were distributed in the model per TABLE 5-4, for a total demand of approximately 9,469 gpm. Only the facilities listed as 'Available' in TABLE 6-2 were used for ADD. (Note: Storage should not be drawn down for this planning scenario.) The modeling results were compared to the criteria identified in TABLE 6-1, and are discussed in Subsection 6.3.6.

6.3.3 Maximum Day Scenario Analysis

To analyze the maximum day scenario for the existing system, simulations were performed using the computer model with MDD. The demands were distributed in the model per TABLE 5-4, for a total demand of approximately 18,176 gpm. Only the facilities listed as 'On' in TABLE 6-2 were used for MDD. (Note: Storage should not be drawn down for this planning scenario.) The modeling results were compared to the criteria identified in TABLE 6-1, and are discussed in Subsection 6.3.6.

6.3.4 Peak Hour Scenario Analysis

To analyze the peak hour scenario for the existing system, simulations were performed using the computer model with PHD. The demands were distributed in the model per TABLE 5-4, for a total demand of approximately 27,264 gpm. Only the facilities listed as 'On' in TABLE 6-2 were used for PHD. (Note: Storage may be drawn down for this planning scenario.) The modeling results were compared to the criteria identified in TABLE 6-1, and are discussed in Subsection 6.3.6.

6.3.5 Fire-flow Scenario Analysis

For this master plan revision, the fire flow scenario was not analyzed.

6.3.6 Analysis Results and Recommended Improvements for the Existing System

Various alternatives were considered to correct the hydraulic deficiencies identified in the hydraulic analysis. The proposed improvements were evaluated for their ability to correct the deficiency and for their cost-effectiveness as compared to other alternatives.

Steady-State Deficiencies

The deficiencies identified in the ADD, MDD, and PHD simulations for the existing system are presented in TABLE 6-3 (Note: This table also includes any existing system improvements for supply and storage from Section 5). These deficiencies were analyzed in detail using the computer model by adding proposed improvements, reviewing the updated results, and repeating this process until acceptable results were obtained.

The distribution system was analyzed to identify areas of the system that experienced pressures below 40 psi or above 125 psi (criteria identified in TABLE 6-1). Various steady-state planning scenarios were used to analyze system pressures under different demand conditions to verify adequate system pressures. Where low pressures were observed during the analysis, one or more approaches were used to mitigate the low-pressure problem. In some cases, low pressures can be corrected with no physical improvement, such as by increasing the pressure setting of an upstream pressure regulating valve. However, sometimes substantial improvements may be required. Improvements may include replacing older pipelines with larger diameter pipelines to reduce friction losses, constructing new pump stations or pressure regulating stations, or modifying the boundaries of an existing pressure zone.

High velocities in water pipelines can also be an indication of an operational deficiency, and can lead to scouring of the pipe lining material or increase the chances of a valve failure. Increased velocities contribute to increased head loss, usually resulting in a less efficient water distribution system. Higher velocities may be acceptable for short-term operation, such as when needed for fire-flow, but otherwise should be lower where practical. The planning scenarios used to analyze the Cordova System for pressure deficiencies were also used to evaluate the velocities under the same demand periods (ADD, MDD, and PHD). The velocity criteria used to evaluate the distribution system for each demand period were defined in TABLE 6-1.

As stated in footnote 'a' of TABLE 6-1, "If velocity or headloss in a pipeline exceeded the criteria listed but did not result in low pressures in the system, the pipeline was not recommended for replacement." Thus, pipelines with velocities above the criteria identified in TABLE 6-1 but below 10 fps were reviewed for excessive pressure loss resulting in low pressures or excessive energy use. Where the velocities did not appear to contribute to pressure problems or excessive pumping, then no deficiency was identified and no improvement was proposed.

The numbering system used in deficiency tables below is a series of three numbers. The first number indicates the planning period: 1 for the existing system and 2 for the 2040 system. The second number indicates the deficiency number, which starts at 1 and increases by 1 for each deficiency identified. The third number identifies the improvement alternative (zero is reserved for the deficiency identification). Proposed improvements to correct the deficiency are numbered starting at 1. Therefore, the alternative number 1.2.3 would be used to identify the third proposed alternative for the second deficiency in the existing system. (Note: Deficiencies identified may not start with the number 1.1.0 if there are deficiencies identified in a prior section of this master plan.)

TABLE 6-3 Existing System Deficiencies and Recommend Improvements for ADD, MDD, and PHD

Deficiency/ Alternative Number	Location	Deficiency	Recommended Improvement
1.1.0	**West Zone**	**MDD headloss**	
1.1.1	6-in AC at Agnes Circle Plant (400 LF section between Rhoda & Moraine)		---
1.1.2	4-in AC back yard main between Ribier, Furmint & Dolecetto		---
1.1.3	8-in AC on Dolecetto, from Chassella to 6-in AC 70 LF south		---
1.1.4	6-in AC on Ambassador, Rossmoor to 125 LF north-east		See Condition Assessment project 2.4.0 (Table 8-2)
1.2.0	**East Zone**	**MDD headloss**	
1.2.1	8-in CI, s/o of Hwy 50 crossing at Gold River Rd and north of Folsom Blvd (100 LF section w/o abandoned Well #15 site)		Upsize existing pipeline to 12-inch PVC
1.2.2	8-in AC, Folsom Blvd, w/o Mercantile Dr		Upsize existing pipeline to 12-inch PVC
1.2.3	6-in AC, Gold River Rd, s/o Coloma Rd to Pyrites Way[a]		Upsize existing pipeline to 12-inch PVC
1.2.4	12-in AC, Point East Dr, Folsom Blvd to Citrus Rd		---
1.2.5	8-in AC, Citrus Rd, Point East Dr to Folsom Blvd		---
1.2.6	6-in AC, Country Rock Way and Mother Lode Cir		Upsize existing pipeline to 8-inch PVC
2.1.0	**East Zone**	**PHD pressure (<40 psi, >30 psi)**	
2.1.1	<40 psi; Tributary Point Area		Future looped distribution system through Westborough development

[a] The Cordova System Map shows this pipeline as 6-in AC, but WO# 11800355 indicates that this pipeline may be 10-in AC, which would resolve the identified headloss issue.

Note: None of the above deficiencies resulted in low pressures in the system. Therefore, these pipelines will not be recommended for replacement due to hydraulic deficiencies alone. However, these pipelines may be recommended for replacement in Section 8 (System Condition Assessment), due to age and material of the main.

SECTION 7

Water Quality Evaluation

The purpose of this section is to provide documentation of Golden State Water's water quality assessment for the Cordova System. Water quality of local groundwater, surface water, and imported water were evaluated based on current federal and state standards and rules.

7.1 Current Status of Drinking Water Quality

The Cordova System is supplied by nine active wells, surface water from the American river, and treated surface water from the wholesaler, Carmichael Water District. The system has six emergency interconnections with California American Water Company (Cal- Am), Sacramento County Water Agency (SCWA), and the City of Folsom.

The drinking water quality of the Cordova System must comply with the Safe Drinking Water Act (SDWA), which is composed of primary and secondary drinking water standards. Compliance with primary drinking water standards is regulated by the U.S. Environmental Protection Agency (EPA). Compliance with both primary and secondary standards is required by the State Resources Control Board, Division of Drinking Water (DDW).

Water quality sampling is performed at the sources to ensure compliance with all regulatory standards. Sources are sampled per the requirements of Title 22 of the California Code of Regulations. Monitored constituents include general mineral, general physical, inorganic, volatile organic, synthetic organic, and radiological compounds/chemicals. The frequency of monitoring depends on the parameter being tested and the concentration of the constituent in the source. Frequencies range from weekly to once every 9 years.

Distribution system water quality monitoring is performed for several water quality parameters in the Cordova System, including general physical parameters, presence of coliform bacteria, chlorine residual, disinfection byproducts, and corrosivity of the water by monitoring lead and copper levels at customers' water taps. The distribution system is tested weekly for the presence of coliform bacteria at representative locations throughout the system; disinfection byproduct samples are collected on a quarterly basis. All monitoring parameters and levels currently meet drinking water standards.

7.2 Surface Water Quality

Surface water from the American River has excellent quality with low turbidity and alkalinity. The water withdrawn from the American River via the Folsom South Canal (FSC) is treated at the Pyrites and Coloma Surface Water Treatment Plants located on the same property. The Pyrites SWTP and the Coloma SWTP are stand-alone treatment facilities. Each SWTP may be operated independently or together at the same time. The two SWTPs share the same raw water supply intake and, when operated at the same time, commingle their respective chlorinated filter effluent water prior to entering three clearwell/reservoirs, arranged in series, for chlorine contact time.

Due to the recreational activity directly upstream of the FSC, an increased level of treatment must be practiced to achieve 4-log Giardia and 5-log Virus total reduction, when monthly median total coliform counts or fecal coliform counts are greater than 1000 or 200 MPN/100ml, respectively. Since both SWTPs share the same raw water source and also currently share the same treatment log credits, both SWTPs are currently required to have the same level of remaining disinfection. Water produced by both plants meets existing drinking water standards and is not expected to be impacted by future regulations currently proposed.

7.2.1 Pyrites SWTP

The Pyrites SWTP consists of two US Filter Actifloc package plants operating in parallel. Each package plant utilizes ballast sand clarification processes followed by typical multi-media gravity filtration. The DDW classifies the package plants as utilizing alternative filtration technology and considers the treatment processes as equivalent to direct filtration methods allowing a 2.0 log Giardia and 1.0 log virus treatment credit.

The Pyrites SWTP treats raw surface water from the American River. At the FSC turn-out, the raw water is treated with potassium permanganate to control offensive and seasonal taste and odors, and to control biological growth in the raw water main. Water served to the Pyrite SWTP flows through two strainers and is then injected with a primary coagulant before flowing through an inline mechanical mixer for chemical dispersion and flash mixing. At this point the water flow is split to serve the two US Filter Actifloc package plants operating in parallel. Each package plant consists of the following unit processes:

- Coagulation (Stage 1 mixing)
- Flocculant Aid and Microsand Addition prior to Injection (Stage 2 mixing)
- Maturation (Stage 3 mixing)
- Clarification/Sedimentation
- Filtration

Water entering the Actifloc treatment process first enters the coagulation chamber for additional mixing. A flocculant aid and suspension of microsand are added to the coagulated water before flowing to the Injection Basin. Here, the water is further mixed before flowing to the Maturation chamber. In the Maturation chamber, floc adheres to the microsand core producing a comparatively heavier floc particle with high settling characteristics. Water then flows to the Clarification Chamber for settling. The settled floc is collected and pumped through a sand separator. The microsand suspension is recycled and added back to the Injection Basin. Settled water leaves the Clarification Chamber up through tube settlers and flows to the filter.

Each package plant consists of one multi-media gravity filter with garnet sand, silica sand and anthracite media. Filtered water exits the filter and Actifloc package plant and flows to an equalization vault. The effluent filter water is then disinfected with chlorine before entering the first of three water storage clearwell/reservoirs arranges in series. Each clearwell/reservoir is equipped with baffles to reduce short circuiting and increase chlorine contact time with the filtered water. The three clearwell/reservoirs have a total nominal capacity of four MG.

7.2.2 Coloma SWTP

After the raw surface water transmission pipeline splits to feed the Pyrites SWTP, the pipeline splits again to feed two parallel pre-treatment trains of the Coloma SWTP, referred to as Basin #1 and Basin #2. Each basin includes the unit processes of flash mixing, coagulation, flocculation and settling. Due to the relatively short detention times in the flocculation and sedimentation basins, the Coloma SWTP is classified as an alternative technology.

Water in each treatment train is injected with a primary coagulant and coagulant aid before dispersion by hydraulic mixing. Coagulated water in each basin is subject to flocculation and settling, before being pumped to ten pressure filters. Settled water from each basin is treated with a filter aid before commingling and entering the pressure filters. Nine of the filters are dual media filters with garnet sand and anthracite, while one is a single media filter with anthracite only. Effluent water from the ten pressure filters is disinfected with chlorine before entering the first of the three baffled water storage reservoirs previously described.

7.3 Groundwater Quality

There are currently nine active groundwater wells within the Cordova System. At each well site, liquid sodium hypochlorite is injected to provide a chlorine residual in the water entering the distribution system. The active groundwater sources currently comply with all primary and secondary MCLs; however, treatment by oxidation and subsequent filtration is required at one well to remove manganese, and treatment by ion exchange is required at three wells to remove perchlorate.

Portions of the basin are severely impacted by groundwater contamination, caused primarily by past waste disposal practice at Aerojet's rocket propellant manufacturing and testing facility. This facility is located immediately upgradient and to the east of the water system. The contaminants consist primarily of volatile organic compounds (VOCs), perchlorate and N-nitrosodimethylamine (NDMA). This contamination has caused the water system to destroy or suspend operation of a number of wells.

7.4 Imported Water Quality

Imported water is supplied into the Cordova System from an interconnection with Carmichael Water District (CWD). The imported water is supplied by the CWD Bajamont WTP. The Bajamont WTP collects raw water from the American River via Ranney collectors, then pumps and treats using membrane filtration, and finally sends to a clearwell/chlorine contact chamber prior to distribution through booster pumps. Water imported from CWD is to replace lost groundwater wells due to historical contamination of the aquifer. Compliance monitoring of the purchased water is performed by CWD.

7.5 Water Quality Evaluation

The following discussion provides information on the relevant water quality evaluation rules for the Cordova System, including:

- Manganese
- Chlorine residual monitoring
- PFAS
- Microplastics
- PCE

7.5.1 Manganese

Manganese occurs naturally in the environment in rocks and soil and is widely used in industrial and manufacturing processes. Levels of manganese above the SMCL of 0.05 mg/L may lead to discolored grey to blackish water and staining of household fixtures. Legacy or historical manganese oxide deposits can accumulate overtime as a scale in water mains. If this scale becomes unstable, manganese oxide minerals can cause grey to black discolored water in the distribution system and customer's water pipes.

It is recognized in professional literature that the SMCL of 0.05 mg/L is too high to prevent discolored water events from manganese. Discolored water events due to mobilized legacy manganese or dissolved manganese in bulk water can occur at concentrations generally above 0.02 mg/L (*Legacy of Manganese Accumulation in Water Systems*, Brandhuber et. al., Water Research Foundation Report #4314, pages 7 and 31, 2015).

Capital, Well #23 recently detected manganese at 27 ppb. Historically, the system complaint numbers have been very low, and complaint patterns haven't suggested an issue with the manganese near this site. However, if relevant complaints start to accrue in the area near Well #23 a study to install manganese treatment on Well #23 may be necessary.

7.5.2 Distribution Chlorine Residual

Agnes, Well #8; Park, Well #17; and South Bridge, Wells #22A and B do not have online chlorine residual analyzers. Chlorinating public water supplies to prevent against disease has been called by the Centers for Disease Control and Prevention (CDC) "…one of the greatest public health achievements of the 20th century."[1] To be effective, free chlorine residuals should be at least 0.2 mg/L at the point of delivery[2], and cannot exceed 4.0 mg/L for either free chlorine or total chlorine as a running annual average.[3] To maintain chlorine

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[1] CDC. November 26, 2012. A Century of U.S. Water Chlorination and Treatment: One of the Ten Greatest Public Health Achievements of the 20th Century. *Centers for Disease Control and Prevention*. Retrieved December 2, 2013 from http://www.cdc.gov/healthywater/drinking/history.html

[2] World Health Organization, Guidelines for Drinking-water Quality, FOURTH EDITION, 2011, page 187; http://www.who.int/water_sanitation_health/publications/2011/dwq_guidelines/en/index.html

[3] CDPH Title 22 (Division 4, Chapter 15.5, Article 2. Maximum Contaminant Levels for Disinfection Byproducts and Maximum Residual Disinfectant Levels, §64533.5) http://www.cdph.ca.gov/certlic/drinkingwater/Documents/Lawbook/dwregulations-2013-07-01.pdf

residual levels in the distribution system at optimal levels, continuous chlorine analyzers should be located at all treatment plants, wells, and distribution system reservoirs. With a continuous chlorine analyzer, the level of chlorine can be kept at a predetermined level using feedback loops with the chlorine injection pump. The analyzer output can be linked into the Supervisory Control and Data Acquisition ("SCADA") system so that if the chlorine levels go above or below a pre-set safe range, Operations personnel receive an alarm. Operations personnel can then go to the appropriate point of chlorination and rectify any problems that are causing the alarm, ensuring a constant and consistent chlorination level in the distribution system to effectively protect the public health. Without access to continuous feed-back from the online analyzer, chlorine residuals are checked only once per day. Therefore, if a malfunction occurs, it could be up to 24 hours before Operations personnel are made aware of and can correct the issue.

7.5.3 Microplastics

On September 28, 2018, Senate Bill No. 1422 was filed with the Secretary of State, adding section 116376 to the Health and Safety Code, and requiring the State Water Board to adopt a definition of microplastics in drinking water on or before July 1, 2020, and on or before July 1, 2021, to adopt a standard methodology to be used in the testing of drinking water for microplastics and requirements for four years of testing and reporting of microplastics in drinking water, including public disclosure of those results. Future water quality monitoring may be needed as implementation of this law occurs.

7.5.4 PFAS

Per- and polyfluoroalkyl substances (PFAS) are a varied and sundry group of compounds used in a variety of industrial and commercial applications including fire-fighting foams, clothing, metal plating, and upholstery.

As part of EPA's third unregulated contaminant monitoring rule (UCMR3) the entry points to the distribution system were monitored for six PFAS including PFOA and PFOS between 2013 and 2015. PFOA and PFOS were not detected above the method reporting limits. The combined reporting limit for PFOA and PFOS was 60 ng/L.

The following outlines regulatory requirements for PFAS:

- In 2015, the EPA released a health advisory for two PFAS compounds, perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), at a combined total of 70 nanograms per liter (ng/L).
- In July 2018, DDW set a notification level for PFOS of 13 ng/L and PFOA of 14 ng/L with a recommendation for source treatment or removal from service at a combined 70 ng/L. In the absence of a federal MCL, several states are in the process of developing MCL for PFAS.
- In March 2019, DDW issued the first phase of mandatory PFAS testing orders for public water systems across California based on proximity to: airports with fire training/response sites and previous PFOA/PFOS detections.

- Mather Well #18 in the Cordova Water System was included in the mandatory testing order. Four quarters of sampling was required by the order. Sampling commenced in April 2019. As of December 2019, PFOA and PFOS were not detected above the method reporting limits.

- In August 2019, DDW revised the notification levels from 13 ng/L to 6.5 ng/L for PFOS and from 14 ng/L to 5.1 ng/L to PFOA.

The regulatory requirements for PFAS are expected to develop over the next one to three years. Regulations for this emerging contaminant will be closely monitored by Golden State Water.

7.5.5 TCE

Dolecetto, Well #6 has detected low levels (up to 0.84 ug/L) of Trichloroethylene (TCE) several times since 2014. The levels are below the MCL (5.0 ug/L). It is difficult to predict the fate and transport of organic chemicals in groundwater; however, if TCE levels increase treatment will be required.

7.5.6 Assembly Bill 1668

This State Assembly Bill sets an indoor water usage limit of 55 gallon per day per person. The Bill also requires the State Water Resources Control Board, in coordination with the Department of Water Resources to establish long-term standards for the efficient use of water and performance measures for commercial, industrial, and institutional water use on or before June 30, 2022. If the implementation of this legislation results in significant reduction of water usage, it may result in increased water age in the distribution system. This may cause corresponding water quality challenges such as low chlorine residual and nitrification. Future water quality studies may be needed as implementation of this law unfolds over the next two to five years.

7.6 Recommended Improvements

The water quality concerns that were discussed in the previous sections are summarized in TABLE 7-1.

TABLE 7-1 Recommended Improvements to Address Water Quality Concerns

Alternative Number	Alternative Description
1.3.0	**Chlorine Facilities**
1.3.1	Install chlorine analyzers at Agnes, Well #8; Park, Well #17; and South Bridge, Wells #22A&B

SECTION 8

System Condition Assessment

The purpose of this section is to provide documentation of GSWC's system condition assessment effort for the Cordova System. This section is organized as follows:

- Previous system condition assessment efforts
- Updated condition assessments

8.1 Previous System Condition Assessment Efforts

More than 10 years ago, GSWC conducted several facility condition assessment efforts, working with multiple engineering consulting companies to develop a complete condition assessment for each of the Company's systems. Facilities in the Cordova System were addressed in this effort.

Generally, the purpose of these studies was to inspect and evaluate existing facilities to determine if upgrades would produce significant benefit to offset expenditures. These studies included the following information:

- Evaluations of the safety of the facilities
- Outstanding code violations
- A general evaluation of condition and reliability

8.2 Updated Condition Assessments

For this Master Plan, GSWC Operations and Planning personnel reviewed the condition of plant facilities and pipeline data within the Cordova System in order to identify the facilities requiring upgrade or replacement. For the pipeline conditional assessments, no specific recommendations were made based solely on condition, but age and material were considered along with pipeline leaks/breaks and input from operations staff.

8.2.1 Facility Condition Review

The purpose of this review was to identify plant improvement projects based on the following:

- Operational needs and requests
- Common items that are not installed at all plant sites
- Recommendations from the previous condition assessments that were not installed

GSWC reviewed each of the following elements to identify potential recommended improvements at each facility:

- Electrical
- Mechanical
- Structural
- Other site improvements

TABLE 8-1 summarizes the recommendations that were developed as a result of the system condition assessment review.

TABLE 8-1 2016 Condition Assessment Plant Projects

Alternative Number	Facility	Project Description	Reason	Priority Category
1.4.0	Folsom South Canal	Intake improvements	Booster pump screens currently backwashed twice a day due to buildup of debris; need to remove additional material earlier in process	Short-term
1.5.0	Coloma WTP	Recoat clarifier	Prolong useful life of clarifier	Short-term
1.6.0	Coloma WTP	Recoat exterior of Reservoir #3	Prolong useful life of reservoir	Short-term
1.7.0	Coloma WTP	Connect filter backwash to system water	Increase CTP capacity. Filtered water is being used for backwash and is reducing the overall output of filters and causing settlement basins to back up during each backwash cycle.	Short-term
1.8.0	Coloma WTP	Facility alternatives study	To determine appropriate course of action for implementing facility improvements to improve the surface water treatment process. Develop PDR and conduct piloting phase.	Short-term
1.9.0	Coloma WTP	Expoxy recoat Sedimentation Basin 1	Basin 1 has insufficient setting time and sludge collects due to old rough concrete. Recoat is needed to limit sludge build up.	Short-term
1.10.0	Coloma WTP	Recoat exterior of Reservoirs #1 & #2	Prolong useful life of reservoirs	Short-term
1.11.0	Coloma WTP	Mitigate ground settling under Reservoir #4	West side of Reservoir #4 shows separation between bottom of tank and top of concrete foundation for ~80 to 100 ft along circumference	Short-term
1.12.0	South Bridge Plant	Replace disinfection facilities	Existing facility showing signs of chlorine corrosion, and has reached the end of its useful life	Short-term
1.13.0	Coloma WTP	Replace filter media for North 4 & South 2	Replace media per schedule	Short-term
1.14.0	Coloma WTP	Replace filter media for North 2 & North 3	Replace media per schedule	Short-term
1.15.0	Coloma WTP	Replace filter media for North 5 & North 6	Replace media per schedule	Short-term
2.2.0	Coloma WTP	Hydraulic improvements	Reduce headloss between Res #1 and Res #4	Long-term
2.3.0	Coloma WTP	Corrosion control	System-wide corrosion control is required if customer population served is >50,000 persons	Long-term

8.2.2 Pipeline Condition Review

In addition to facility condition, GSWC monitors distribution system condition through the tracking of pipeline leaks/breaks on an annual basis; FIGURE 8-1 is a map of the leaks in the Cordova System from 2014 to 2018. This information was used, along with additional risk assessment analysis, to make recommendations regarding potential CIP projects and in the prioritization of those projects. (See GSWC's *Pipeline Management Program Report* and *Risk Based Asset Management Program Report*.)

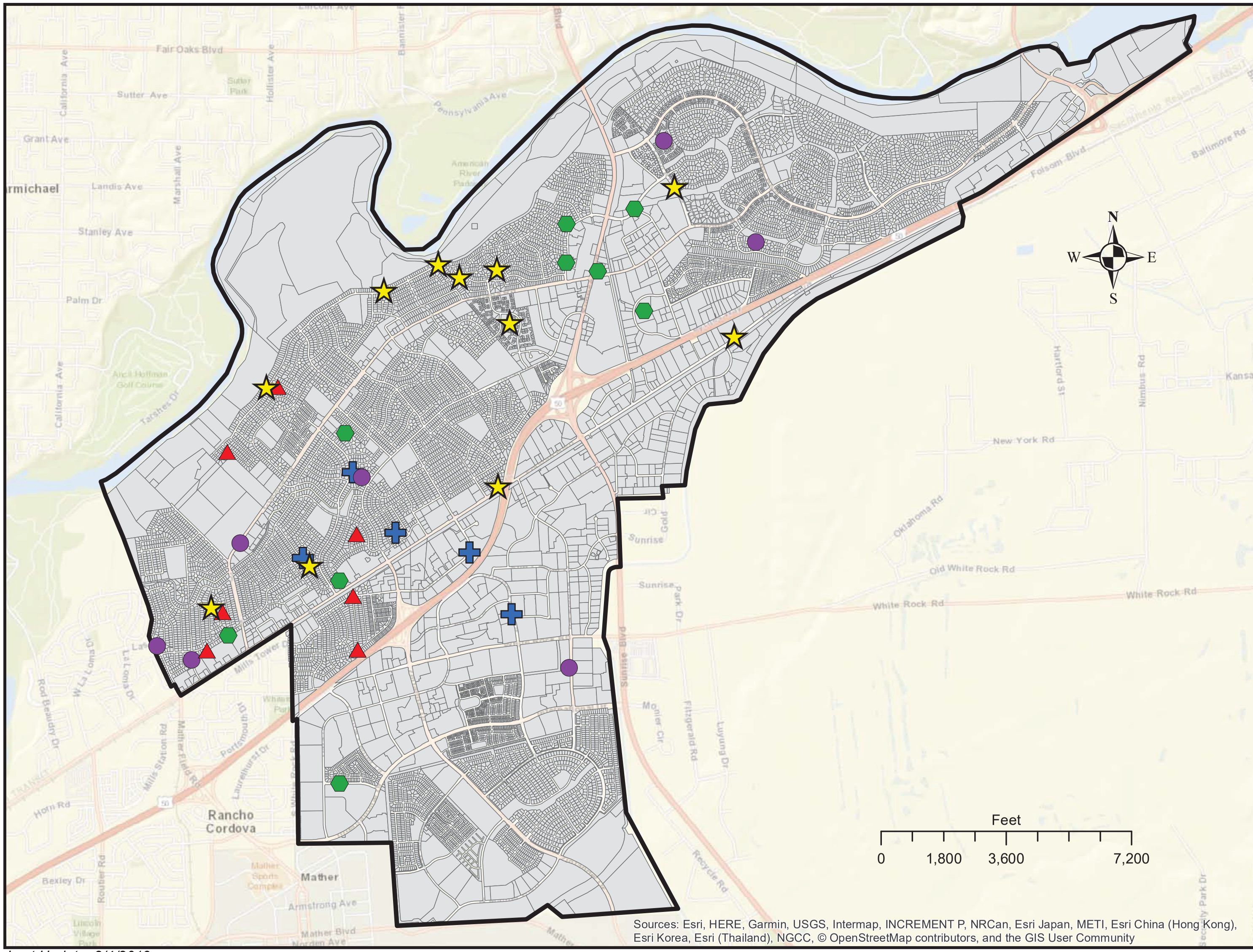
As part of the overall main replacement program for the Cordova System, GSWC is also striving to install new water lines in the public roadways to replace old and deteriorating water lines located in the backyards of customers. Backyard mains pose several problems to Operations personnel, including difficult access to in-line gate valves, repair of main breaks, installation of water meters, meter reading, and issues of physical safety (entering private property, dog bites, etc.). In today's world, it is more difficult to gain access to customer rear yards and/or access the rear yards with the equipment and tools necessary to perform main repairs and maintenance. The installation of new mains within the public streets enables Operations to more readily perform monthly meter reading and access gate valves for the purpose of main flushing, general maintenance, and emergency main repairs.

TABLE 8-2 2016 Condition Assessment Pipeline Projects

Alternative Number	Recommended Improvement	Reason	Priority Category
1.16.0	Las Casas Way, Palo Vista Way & La Presa Way, Approximately 2,525 LF of 8-inch PVC	Eliminate backyard mains, unmetered parcels; existing 4" AC main on Las Casas is back of walk, under customer-planted trees	Short-term
1.17.0	Agnes Cir, Moraine Cir, Thores St & Rinda Dr, Octavia Way, Rhoda Way & Maxine Way, Approximately 8,750 LF of 8-inch PVC	Eliminate backyard mains, unmetered parcels; existing main south of Moraine Cir is near a retaining wall, buried 6 ft deep	Short-term
1.18.0	Marcel-Hunt Area Main Replacements, Approximately 4,800 LF of 8-inch PVC	Increase fire flow and water quality and reduce water loss; backyard pipelines are susceptible to costly damage and meters are difficult to read, maintain, and replace.	Short-term
1.19.0	Mills Park Drive Main Extension, Approximately 400 LF of 8-inch PVC	Improve fire flow, water quality, water circulation, and provide a second source of water supply to 26 single-family residences and a 48-unit apartment complex	Short-term
1.20.0	Ganzan-Augibi Area Main Replacements, Approximately 3,100 LF of 8-inch PVC	Increase fire flow and water quality and reduce water loss; backyard pipelines are susceptible to costly damage and meters are difficult to read, maintain, and replace.	Short-term
2.4.0	Ambassador Dr, Rossmoor to Klamath River, Approximately 5,400 LF of 12-inch PVC	Replace/upsize 6" & 8" AC to provide secondary path for flow from CWD main toward the East Zone; upsize 6" bottleneck between Ambassador and Klamath River	Long-term

Figures

CORDOVA SYSTEM LEAK MAP 2014 - 2018



Year & Number of Leaks

- 2014 - 5 Leaks
- 2015 - 7 Leaks
- 2016 - 9 Leaks
- 2017 - 7 Leaks
- 2018 - 11 Leaks

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Last Update: 2/4/2019

SECTION 9

Capital Improvement Program

The capital improvement program (CIP) is an essential component of this water master plan. The CIP summarizes recommended facilities, and establishes the priority and timing of necessary improvements. The recommended improvements were analyzed and evaluated in the previous sections of this report.

The recommended improvements were prioritized into two categories—short-term (existing system) or long-term (2040 system)—to identify when these improvements are required. The project selection and prioritization process considered various issues, including existing deficiencies, projected demands, water quality, regulatory compliance, reliability and facility condition.

9.1 Cost Estimation

No cost estimates are included in this master plan, as the final costs of a project, and the project's resulting feasibility, will depend on actual labor and material costs, inflation, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. Prior to design and construction of any recommended project in this master plan, a detailed project cost estimate will be created.

9.2 Project Prioritization

The following descriptions define how projects were prioritized into one of the two categories:

- **Short-term improvement projects** were based on deficiencies identified in the existing system. Deficiencies included supply and storage, hydraulic, condition assessment, and water quality. Operational improvements were included as a short-term improvement only when a significant short-term benefit was identified.

- **Long-term improvement projects** are based on deficiencies identified beyond the short-term planning years through the year 2040. The water system was assumed to be built out by the year 2040. The long-term improvements are typically projects necessary to meet future demands and replace or rehabilitate aging infrastructure.

9.3 CIP Projects

TABLE 9-1 lists the recommended improvements for the Cordova System. Each project is assigned a unique identification number and a priority: short-term or long-term. Short-term pipeline projects are shown on FIGURE 9-1.

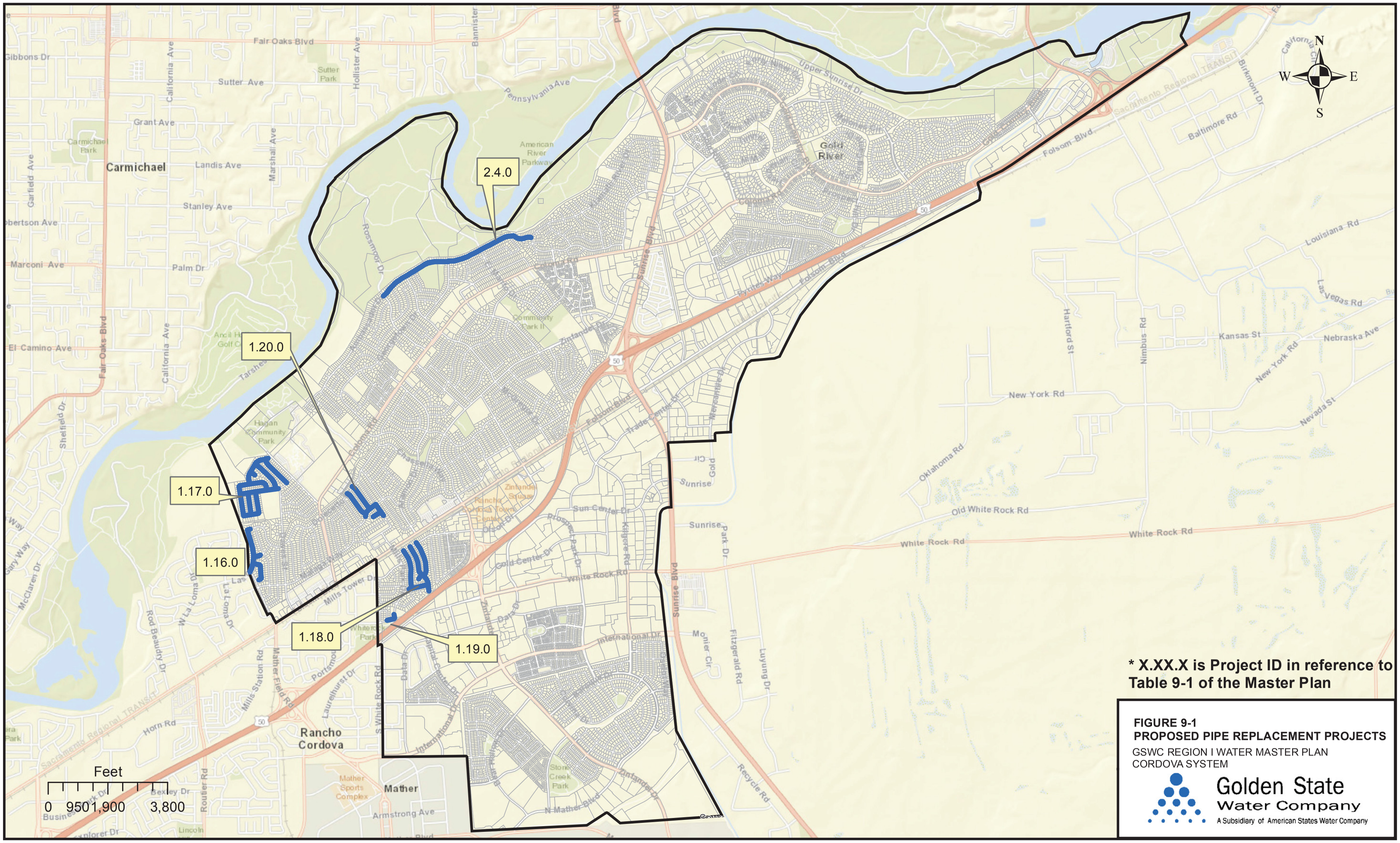
TABLE 9-1 Summary of Recommend CIP Projects

Project ID	Recommended Improvement	Improvement Type	Priority Category
1.3.1	Install Chlorine analyzers at Agnes, Well #8, Park, Well #17, and South Bridge Wells #22A&B	Water Quality	Short-term
1.4.0	Construct intake improvements at Folsom South Canal	Conditional Assessment	Short-term
1.5.0	Recoat clarifier at Coloma WTP	Conditional Assessment	Short-term
1.6.0	Recoat exterior of Reservoir #3 at Coloma WTP	Conditional Assessment	Short-term
1.7.0	Connect filter backwash to system water at Coloma WTP	Conditional Assessment	Short-term
1.8.0	Facility alternatives study at Coloma WTP	Conditional Assessment	Short-term
1.9.0	Epoxy recoat Sedimentation Basin 1 at Coloma WTP	Conditional Assessment	Short-term
1.10.0	Recoat exterior of Reservoirs #1 & #2 at Coloma WTP	Conditional Assessment	Short-term
1.11.0	Mitigate ground settling under Reservoir #4 at Coloma WTP	Conditional Assessment	Short-term
1.12.0	Replace disinfection facilities at South Bridge Plant	Conditional Assessment	Short-term
1.13.0	Replace filter media for North 4 & South 2 at Coloma WTP	Conditional Assessment	Short-term
1.14.0	Replace filter media for North 2 & North 3 at Coloma WTP	Conditional Assessment	Short-term
1.15.0	Replace filter media for North 5 & North 6 at Coloma WTP	Conditional Assessment	Short-term
1.16.0	Las Casas Way, Palo Vista Way & La Presa Way Main Replacements	Conditional Assessment	Short-term
1.17.0	Agnes Cir, Moraine Cir, Thores St & Rinda Dr, Octavia Way, Rhoda Way & Maxine Way Main Replacements	Conditional Assessment	Short-term
1.18.0	Marcel-Hunt Area Main Replacements	Conditional Assessment	Short-term
1.19.0	Mills Park Drive Main Extention	Conditional Assessment	Short-term
1.20.0	Ganzan-Augibi Area Main Replacements	Conditional Assessment	Short-term
2.2.0	Reduce headloss between Res #1 and Res #4 at Coloma WTP	Conditional Assessment	Long-term
2.3.0	System-wide corrosion control	Conditional Assessment	Long-term
2.4.0	Abassador Dr, Rossmoor to Klamath River Main Replacements	Conditional Assessment	Long-term

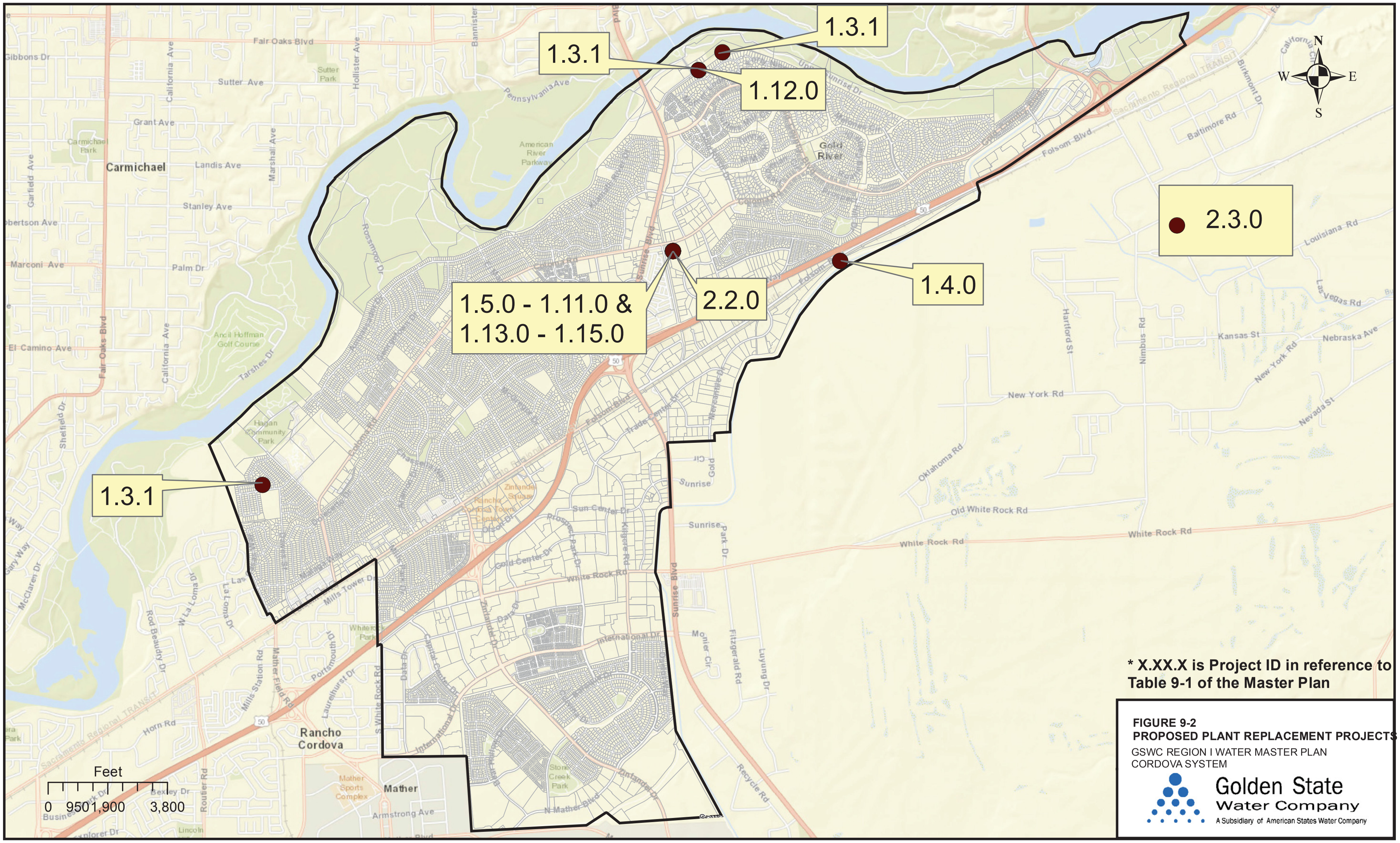
9.4 Additional Considerations

As part of the overall main replacement program for the Cordova System, GSWC is also striving to install new water lines in the public roadways to replace old and deteriorating water lines located in the backyards of customers. Installation of new mains within the public streets will continue as part of the long-term pipeline replacement/management program in conformance with KANEW replacement recommendations.

Figures



Last Update: 11/25/2019



* X.XX.X is Project ID in reference to Table 9-1 of the Master Plan

FIGURE 9-2
PROPOSED PLANT REPLACEMENT PROJECTS
GSWC REGION I WATER MASTER PLAN
CORDOVA SYSTEM

Golden State Water Company
A Subsidiary of American States Water Company

Last Update: 12/18/2019

SECTION 10

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